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CATALOGUE
OF THE
FOSSIL CEPHALOPODA
IN THE
BRITISH MUSEUM
(NATURAL HISTORY)

PART IV



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OF THE
FOSSIL CEPHALOPODA

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BRITISH MUSEUM
(NATURAL HISTORY)

PART IV
THE AMMONOIDEA OF THE TRIAS

BY
L. F. SPATH, D.Sc., F.G.S.

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PREFACE

DR. SPATH, who is well known for his encyclopædic knowledge of fossil Cephalopoda, has undertaken the revision of the Triassic Ammonoidea. This volume is the first of two, written by him and dealing with that group. It includes the four super-families Pronoritida, Xenodiscida, Meekoceratida and Phylloceratida, as well as part of the Ceratitida, nearly all occurring in the Lower and Middle Trias; the rest of the Ceratitida and the remaining super-families, all of Middle and Upper Trias age, will be considered in the succeeding volume, which will also contain a detailed list of literature.

The number of forms included is so great, and the literature dealing with them so extensive, that no attempt has been made to give the full synonymy of each species. This was given in Diener's "*Cephalopoda triadica*" of Frech's 'Fossilium Catalogus', 1915, and in its sequel by Kutassy, in 1933; and it has been assumed that every student of ammonites will have access to that work. Reference is given to the literature which is not mentioned in these two catalogues.

Having read this volume the reader will have especially noticed two conclusions—the stratigraphical treatment of the Triassic System, and the fluidity of the Ammonite classification. Dr. Spath is convinced that the Triassic System is known but piece-meal, and its total range in time has been considerably under-estimated; that ammonite faunas which have been regarded as contemporary are really as heterochronous as they are dissimilar; in other words, that the Triassic System is in much the same condition as was the Jurassic System some forty years ago, when the late Mr. S. S. Buckman first handled it; and that the only possible way to approach and treat the Trias is by the methods adopted by Buckman in approaching and treating the Jurassic System, but applied with more caution.

It is to some extent owing to this uncertainty of the stratigraphical order and to gaps in the detailed succession that the vagueness of the ammonite classification is due; but not alone to this cause. Perhaps beyond other orders of invertebrates the Ammonites offer almost insuperable difficulties of classification, largely owing to their exuberant variability and the comparatively few characters upon which the changes of form are rung. So long as the principle of recapitulation could be relied upon to elucidate their phyletic relationships, it was possible to classify ammonites with some show of reason; but when the phenomenon of cænogenesis is claimed as commonly prevalent, ammonite classification becomes far more difficult; and the difficulties are almost insuperable when the principle of recapitulation is entirely disavowed, and as discredited as Dr. Spath in this volume declares it to be.

It follows, then, that the implications of phylogeny in the systematic scheme here put forward are but faint, and such relationships as it expresses are mainly dependent for their sanction upon the stratigraphic position of the forms described. It is only necessary to note that the alternative relationships so often admitted by Dr. Spath, and implying such widely divergent views, show on what a fluid basis the classification which he prefers is based; and that until a more stable phylogeny is expressed, it is impossible to say how far the principle of recapitulation proves helpful or useless to indicate relationship.

The two volumes will, however, give a complete conspectus of all the known Triassic forms, classified as a system, which, if open to criticism in the elasticity of its phylogenetic implications, at least contains as much phylogeny as our present knowledge allows. If it does not solve the problem of ammonite evolution to everyone's satisfaction, it is a great contribution to the facts on which any future solution must depend.

Throughout the preparation of this work, Dr. Spath has had the clerical help of Mr. A. Reeley, especially in checking, labelling and preparing the index.

W. D. LANG,
Keeper of Geology.

June, 1934.

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PRESENTED

29 AUG 1934

PART I.—INTRODUCTION

A. GENERAL CONSIDERATIONS.

THIS volume of the Catalogue deals only with the Triassic Ammonoids, and its scope is strictly defined, even in the case of those families that include both Permian and Triassic forms. The volume, therefore, is not a supplement to the previous volume (III) published thirty-six years ago, when there were few Permian ammonoids in the collection; it also avoids the problem of differentiating goniatites from ceratites and ammonites. Of course it has been accepted more or less generally that the subdivision of the lobes in a Carboniferous *Pronorites* or *Dimorphoceras* does not make them ceratites, any more than the entire lobes and saddles of a Cretaceous dwarf-form, like *Flickia*, make it a goniatite. Again, in some Permian Popanoceratids, the bases of most or all of the lobes may be subdivided, but in others the subdivision also affects the sides of the saddles; and the Popanoceratidæ may thus be taken to be a "ceratite" family; on the other hand the Cyclolobidæ, another Permian family, show far more complex suture-lines than many Cretaceous ammonites. In other genera, like the Triassic *Acrochordiceras* or *Beyrichites*, it is impossible to separate the species with ammonitic saddles from those with ceratitic suture-lines. Hard and fast rules are clearly out of place, and the inclusive term Ammonoidea is used for all, especially since the family names Goniatitidæ (which has priority before Glyphioceratidæ) and Ceratitidæ now have a very restricted meaning. Nothing results more clearly from recent research than that true ammonites were already very prolific in the Upper Palæozoic, and that the Permian system has fully justified its existence.

Unfortunately it is impossible at present to obtain from text-books a clear picture of the interrelations of the Ammonoidea. Every palæontologist feels the lack of a useful classification of the Ammonoidea as a whole, or deplors the fact that there is as yet no settled system (A. Morley Davies, 1920). Diener, after Mojsisovics the greatest authority on Triassic cephalopods, was attacked for listing the Triassic

ammonite genera in alphabetical order. He confessed that this plan was adopted, not only because it considerably simplified the use of his catalogue, but also because it seemed to him inadvisable, in view of the unsatisfactory state of ammonoid systematics, to introduce yet another classification. It is deplorable that Diener left no better summary of his views than is incorporated in his classification of the Triassic cephalopoda in Volume IV of Gürich's 'Leitfossilien' (1925). But goniatite systematics is in no better state—a fact which may excuse the present attempt, however inadequate, to review them.

On examining previous work it becomes clear, first of all, that Ammonoidea are a far too homogeneous group to be readily divisible into such larger suborders as would satisfy all workers; also, that unless we are satisfied to accept a large number of families of extremely complex interrelations, classifications will have to be stratigraphical. "Ammonoidea permiana" and "Ammonoidea triadica" may be, even from a biological point of view, less objectionable divisions than meaningless suborders like "Meso-" or "Neo-ammonoidea", and, after all, a classification by age is more likely to express evolution than one that neglects the most important time element.

In a recent paper¹ on the "Evolution of the Cephalopoda" I discussed the origin of the Ammonoidea and the value of their various features for classificatory purposes. I hold that the absence of a settled scheme of subdivision of the Ammonoidea is partly due to the exaggerated value attached in the past to so-called palingenetic "evidence". This, of course, affects the goniatite families, here briefly reviewed, as much as all the Triassic stocks described in detail in the systematic part; and when starting on this volume (in January, 1925), I found that I should have to work out my own classification. This I desired to make elastic in view both of so much uncertainty, biological and stratigraphical, as well as of lack of material; but, of course, it is always easier to separate than to unite. In many cases the affinities of incompletely known forms had to be assumed; and the correctness or otherwise of such guesses, based merely on practical experience, will be matter for future research. I have, however, avoided as much as possible long "series"; because to link up, for example, the Devonian *Beloceras*, the Lower Triassic *Procarmites*, and the Upper Triassic *Carnites* (as Arthaber does) seems to me a

¹ *Loc. cit.* (Biol. Reviews), 1933, p. 418.

return to that stage in zoological systematics when aquatic mammals were grouped with fishes on account of similar external shape. Some stocks (*Sageceras*), no doubt, had a long range, others quickly went to extremes, and it is generally possible to link up such extremes with some less modified contemporary stock. The enormous extension of the Triassic time-sequence, discussed in the section on Chronology (p. 20), and the recognition of mere stratal position as something very different from equivalence in time of certain beds, also affected the classificatory scheme here put forward. The order in which the families are dealt with in the systematic portion below is, however, purely arbitrary. Stocks may be separated from their derivatives by other groups, or by offshoots of the same ancestral family. This is objectionable; but any different grouping, in tabular or book form, would have led to precisely similar separations of closely-allied families, which should be kept together in an ideal classification.

Arthaber's (1931, p. 630) and Kutassy's (1933, p. 378) objections that ammonoid systematics is becoming too complicated to be memorized need not be taken too seriously. Many of the genera and families here adopted were established by Waagen and Hyatt many years ago; and when their contents have here been modified, it is in accordance with the new interpretation of the type species or genus, necessitated by additional information, especially as to succession in time. This complication is probably felt at least as much in other groups, from foraminifera to mammals, and is trifling in comparison with complications made by the advance of knowledge, for example, in chemistry. On the other hand, existing nomenclature has proved more of a hindrance than a help in other orders than Ammonoidea.

The narrow interpretation of species adopted by such masters as Waagen and Mojsisovics is not here condemned, as it was by Wepfer (1913, p. 425). If an example should be transitional between, or resemble either of, two species of *Olenikites*, it would not matter which name was used; in fact *Olenikites* sp. would be quite as acceptable so long as the genus is correct. But the multiplication of generic and sub-generic names may be held to be more objectionable by those who do not realize how fragmentary is the evidence preserved to us in the sediments. Again, it must be left for future discoveries to prove the necessity of the generic separation here advocated. It may be a matter of opinion whether one admittedly

homogeneous group should be relegated to a single species (*e. g.* *Anasibirites multiformis*, Welter), or divided up among a number of genera (as established in Utah for the same group); but far more difficult is the reconciliation of the undoubted affinities between the extremes of this group and members of such apparently widely distinct families as Sibiritidæ and Meekoceratidæ, which are placed in different sub-orders, for instance, by Arthaber (1911), or in different super-families by Hyatt (1900). All ammonites may eventually be found to be connected by transitions; and, although it seems preferable to make yet another attempt at subdivision, than to rest content with mere alphabetical listing, the reconciliation of an essentially genetic classification with practicable systematics is not easy, even with well-established groups.

In order to avoid repetition, throughout this volume cross-references are given by means of authors' names and dates only. A complete bibliography will be included at the end of this catalogue. In the systematic part it has also been considered unnecessary to repeat the full synonymies given in the two parts of the 'Fossilium Catalogus', I, no. 56—Part I (by C. Diener, 1915) and Part II (by A. Kutassy, 1933). These include lists of literature, and are works to which every student of Triassic ammonoids is assumed to have access. Unfortunately in these there are mistakes¹ and omissions,² and the selection of types is often vague. Thus on p. 597 the type of *Nannites dieneri*, Hyatt et Smith, 1905, is quoted as plate vii, figs. 5–25. These figures include six different specimens, of which one (figs. 10–13) was especially designated by the authors

¹ For example, mis-spelt specific names, like *Judicarites statuei* (instead of *stautei*), or mis-spelt authors' names, like Krauss (instead of Kraus) may be misprints, although they occur too often; on p. 549 *Judicarites eury-omphalus* (instead of *euryomphalus*) is also cited as T. XII (instead of XIII). More serious are wrong dates, as *e. g.* *Flemingites*, Waagen, 1895 (instead of 1892), which occurs in both Diener and Kutassy.

² The suppression of a number of genera may be intentional, but a reference to many of Diener's own genera of 1916 ('Centralblatt', p. 101) would have been desirable, especially since Kutassy listed the genus *Fremontites*, Smith, 1927 (wrongly given as Hyatt and Smith, 1905), which is an absolute synonym of Diener's *Parahauerites* (1916). *Svalbardiceras*, Frebold, 1930, *Diphyllites*, Jullien, 1911, and other isolated genera seem to have been missed unintentionally, but *Paraplicites*, of no standing, is listed, as are such pre-occupied names as "*Aspidites*" (= *Clypeoceras*, Smith, 1913); "*Goniodiscus*" (= *Hemiprionites*, Spath, 1929); "*Margarites*" (= *Hoplotropites*, Spath, 1929); "*Polycyclus*" (= "*Smithoceras*", Hanna, 1924, non Diener, 1907).

as the holotype. The same applies, *e. g.*, to *Glyptophiceras gracile*, Spath (p. 516), where plate vii, figs. 3-6, includes the holotype (fig. 5), a paratype (fig. 3) and two more examples. But in other cases no holotype was selected by the author, for instance, in the case of *Ophiceras sakuntala*, Diener, 1897, where the reference (p. 605) is to plate x, figs. 1-8, and pl. xi, figs. 1, 2, 4, *i. e.* to eleven specimens. In the synonymy below (p. 76) fig. 1a-c is quoted as the lectotype, but where only one example has been figured, it is assumed that the author intended this to be the holotype.

In conclusion. I must gratefully acknowledge the constant help and ready advice I have received during the progress of this volume since 1925 from the former Keeper of the Geology Department of this Museum, Dr. F. A. Bather, and especially his successor, Dr. W. D. Lang, who has had the onerous duty of editing this work; also to Dr. C. D. Sherborn and Mr. A. Reeley, of the same Department, for continued bibliographic and clerical assistance. I likewise have to thank numerous correspondents at home and abroad for keeping me posted with the results of their researches, and I am especially grateful to Dr. Lauge Koch, of Copenhagen, for enabling me to study the extraordinarily rich collections of Trias ammonites gathered by successive Danish State Expeditions to East Greenland.

B. THE GONIATITE FAMILIES.

(a) THE PREVIOUS VOLUME OF THIS CATALOGUE.

In 1897, when Messrs. Foord and Crick published the third volume of this Catalogue, they adopted a classification based "in the main" on the work of Hyatt; but they "incorporated the results of subsequent work on the subject" (p. xviii). The cephalopoda described in that volume were thus classified under the following headings:

Family BACTRITIDÆ.	Family PRIMORDIALIDÆ.
Suborder Ammonoidea.	„ MAGNOSELLARIDÆ.
Family CLYMENIDÆ.	„ GLYPHIOCERATIDÆ.
„ NAUTILINIDÆ.	„ PROLECANITIDÆ.

In the present volume it is not intended to revise these families in great detail; but since in all existing classifications they are directly or indirectly linked with the Triassic families now to be described, and since there can be no doubt that the early Triassic stocks are the direct descendants of certain Permian forerunners, whether ammonites, ceratites, or goniatites,

it is impossible to avoid discussion of the ancestral stocks. Three of the family-names used in the preceding volume are inadmissible; if, however, Agoniatitidæ (which includes the Anarcestidæ) is used instead of Nautilinidæ, Gephuroceratidæ¹ instead of Primordialidæ, and Tornoceratidæ instead of Magnosellaridæ, the families differ little from those recognized at the present day.

The Bactritidæ need not now be considered; *Bactrites* is a synonym of *Orthoceratites* and a nautiloid.² On the other hand, if *Lobobactrites ellipticus* (Frech) is as close to "*Mimoceras*" (= *Gyroceratites*) as authors from Hyatt to Schindewolf held, then it must be a straightened-out Agoniatitid. The family Bactritidæ thus disappears altogether, and Schindewolf's Gyroceratitidæ becomes subordinate to the Agoniatitidæ.

In a paper dealing with the origin of the Ammonoidea² I have shown that the Clymenidæ left no intra-siphonate descendants, and that Schindewolf's derivation of many Triassic, and of all the Jurassic and Cretaceous, ammonites from Clymenids was based on very incomplete knowledge of the vagaries of the siphuncle in young ammonoids. The position of this organ is merely one of a number of systematic characters, and it is impossible to appraise it more highly than any other feature. If an *Oxyclymenia* moved its siphuncle to the ventral side, the resulting ventral lobe would produce the suture-line of that Australian *Pseudoclymenia* recently described by Delépine³ which, significantly enough, is the only "Clymenid" in the Upper Devonian *Sporadoceras* beds of that continent. Even if the siphuncle be still more variable than I admit, the Clymenidæ cannot be connected with any Triassic stock, and need not be further discussed; but I may recall that Sobolew (1914) took the Clymenids to be merely intra-siphonate mutations of normal goniatites.

Of the remaining five families, two, namely the "Glyphioceratidæ" (*recte* Goniatitidæ) and Prolecanitidæ, have been considered by all authors to be the direct ancestors of certain Triassic stocks; but they are so intimately related to the three earlier families, that these also cannot be left out when the results of recent research on goniatites and modern attempts to trace

¹ Hyatt's original spelling was *Gephuroceras*, and the alteration to *Gephyroceras* (by Zittel), although universally adopted, cannot stand.

² L. F. Spath: "The Evolution of the Cephalopoda". 'Biological Reviews', October, 1933, p. 446.

³ 'Proc. Geol. Soc.', no. 1267, July 26th, 1933, p. 118.

the connection between them and their Triassic successors are discussed. Without a proper understanding, especially of the Permian ancestral forms, it is difficult satisfactorily to classify the host of ammonites that existed during the acme of this group in Triassic times.

(b) ATTEMPTS AT THE CLASSIFICATION OF THE GONIATITES.

1. *Haug*. In the previous volume of this Catalogue, reference was made to the works of the late E. Haug (1894). A significant remark by him was there quoted (p. 13), namely, that it was best to dispense with any great divisions in the Ammonoidea and to separate them for the present into families and genera only. This is a conclusion to which the uniformity of the ammonoid stock eventually leads every observer. Nothing was said, however, of the validity of Haug's own two "phyla" of Prolecanitidæ and Glyphioceratidæ; and, in spite of his own injunction, Haug in a paper (1898) that appeared after the publication of the previous volume, considered that two additional main "phyla", namely the Gephuroceratidæ and Agoniatitidæ, with the "Ibergiceratidæ", ranged up into the Trias. It may be pointed out that, whereas, in 1894, Haug correlated his two great "phyla" with Mojsisovics's divisions of Triassic ammonites, Leiostroaca and Trachyostraca respectively, in his later work he classified Glyphioceratidæ (with the Devonian Anarcestidæ) as Longidoma, and the other "phyla" as Brevidoma. These two great divisions, according to the length of the body-chamber, were used again by Arthaber (1911), but under the names of Mikrodoma and Makrodoma; the immediate rejection of this classification, however, has been almost universal. Of all the single characters relied on for the grouping of the larger divisions, the length of the body-chamber is probably the least useful.

Haug's scheme of 1898 was no improvement on that of 1894, in so far as the tracing back of Triassic stocks to Devonian families is concerned; for example, neither the derivation of *Monophyllites* from *Nomismoceras* and *Gephuroceras*, nor of *Megaphyllites* from Gyroceratids, has been accepted by later workers on ammonites. In his 'Traité de Géologie' (1907) Haug still retained his four "phyla". Of these, the Agoniatitidæ, supposed to be represented in the Trias by the single genus *Ussuria*, are an unnatural series. The genus *Daræilites*, represented on p. 755 as a member of Prolecanitidæ, is placed with its supposed descendants, the Meekoceratids, in

Gephuroceratidæ in a later part of the work (p. 858, table). The resemblance of the Triassic Pinacoceratidæ to the Devonian *Beloceras* is also purely superficial, and it will be shown below that Pinacoceratids are intimately connected with *Gymnites*, and thus would also have been derived from the "Prolecanitid stock". I have previously (1914, p. 359) had occasion to differ from Haug in the derivation of Phylloceratids, but it will be seen that, on the whole, Haug's scheme, like most others suggested, amounts to the recognition of discoidal Pronoritid and globose Glyphioceratid stocks of smooth goniatites gradually passing from the goniatite to the ammonite stage, irrespective of ornamentation in lateral (trachyostracous) offshoots.

2. *Hyatt*. Hyatt's comprehensive scheme of 1900 may next be considered. He divided all extra-siphonate Ammonoidea into eight sub-orders, the names of which, with the suffix "-campylus", signifying curve, were given with reference to the "saddle inflections." Thus Microcampyli included Bactritidæ, "Nautlinidæ" (=Anarcestidæ and Agoniatitidæ), Aphyllitidæ and Pinacitidæ. The sub-order thus corresponded with the family Agoniatitidæ as here understood, with the exception of the genus *Prolobites* Karpinsky, which, with other Prolobitids and Cheiloceratids is here connected with Tornoceratidæ.

If all of Hyatt's groups were, like the Microcampyli, morphologically homogeneous, even if heterophyletic, his classification no doubt would long ago have been adopted. But Hyatt's second sub-order Mesocampyli, though stated to be merely a provisional intermediate group, showed the weakness of his classification, due to the neglect of the time-element. Hyatt, for example, included the genus *Milleroceras*, based on *Goniatites parrishi*, Miller and Gurley, with "Primordialidæ" (corresponding to the Gephuroceratidæ of the table on p. 19). Prof. J. Perrin Smith, who examined the holotype of this species, was convinced that it is merely the young of some member of the "Glyphioceratidæ", probably either *Gonioloboceras* or "*Dimorphoceras*" [*Neodimorphoceras*]. He added that the occurrence of the Primordialidæ in the Upper Coal Measures was extremely unlikely, since that family was not known above the Devonian. The Neoicoceratidæ, also an offshoot of Goniatitida, were similarly included by Hyatt in the Mesocampyli; and it will be shown that over and over again this author grouped together homœomorphs of widely different ages on account of a resemblance, often superficial, in the one character of the "saddle-inflections".

The sub-order Eurycampyli, comprising one Palæozoic and two Triassic super-families, again suffered from Hyatt's usual practice of separating closely allied genera in widely different groups. The Magnosellaridæ, including what are here separated as Tornoceratidæ (and Cheiloceratidæ), the Pericyclidæ, the "Glyphioceratidæ" (including the Goniatitidæ, Gastrioceratidæ and Schistoceratidæ), the Dimorphoceratidæ and the Thalassoceratidæ, might be homogeneous enough to justify their inclusion in one sub-order, though here again Hyatt included the Carboniferous *Gonioloboceras* with the Devonian "Magnosellaridæ" rather than with its contemporaries and allies, the Goniatitids in the wider sense. What cannot be admitted, however, is the inclusion in the same sub-order of the Upper Triassic Tropitidæ. These are related neither to the Goniatitids (or the still earlier Anarcestinæ, which they are said to resemble in the ephebic stage), nor to the Nannitida, the third super-family in the Eurycampyli.

The Glossocampyli, with the four families Pharciceratidæ, Beloceratidæ, Sageceratidæ and Hedenstrœemitidæ [*sic*], again include Devonian and Triassic forms, entirely unrelated, but showing external similarity.

The four sub-orders hitherto discussed were taken by Hyatt to be equivalent to the former group of "Goniatitidæ", and his fifth sub-order Discocampyli corresponded to "Ceratitidæ", all of Triassic age. As the families included in the Ceratitidæ are discussed in the following pages, and in some cases are shown to be more closely related to groups referred by Hyatt to different sub-orders, than to others placed with them in Discocampyli, there will be no need to go into detail here.

Hyatt's sixth sub-order, the Phyllocampyli, including the Prolecanitida and the remaining super-families of Triassic Ammonites, namely, the Lobitida, Arcestida and some "Phylloceratida", is of interest on account of the association of Arcestids with the Prolecanitida. I believe the connection to be only indirect (by way of the Ophiceratidæ of Table I, p. 19), but Hyatt was probably nearer the mark here than any of his successors; for J. Perrin Smith attached both the Arcestidæ and the Tropitidæ (of Hyatt's "Eurycampyli") to "Glyphioceratidæ"; and, in the same author's revision of the chapter on Cephalopoda in the second edition of Eastman's translation of Zittel's 'Text-book of Palæontology' (1913, p. 640), the Arcestidæ are stated to be "undoubtedly derived from

the gastrioceran branch of 'Glyphioceratidæ', but may be polyphyletic inasmuch as both *Agathiceras* and *Schistoceras* may be radicals of sub-groups". In the fifth German edition of Zittel's 'Grundzüge der Paläontologie', revised by Dr. Broili (1921, pp. 547 and 549), Cyclolobidæ are also derived from Goniatitids, and Arcestidæ in their turn are believed to be descended from Cyclolobidæ. Arabu (1933, p. 261) still echoes this generally accepted opinion.

With Diener (1895*b*, p. 81) we must consider the Lobitidæ to be merely a sub-group of Arcestids; Phylloceratidæ—which undoubtedly persist from the Lower Trias to the uppermost Cretaceous—are continuous with the Paralecanitid stock, shown in the diagram (p. 19). Yet the intermediate Ophiceratids and closely allied "Meekoceratids" are put by Hyatt into a different sub-order. The Phyllocampyli also are therefore not in any way a systematic unit. Since even J. Perrin Smith, a disciple of Hyatt, did not recognize Hyatt's subdivisions, and since they have not been adopted by any student of Triassic ammonites, there need be no hesitation now in rejecting them.

3. *Arthaber*. Arthaber's ambitious attempt to classify the ammonoids of the Trias has already been referred to; but it has entirely miscarried. His "phyla" are assemblages of heterogeneous elements, as Diener (1913, p. 3) pointed out; but it may here be noted that whilst Arthaber admits the possibility that his "phyla" Tornoceratea and Gephuroceratea, on the one hand, and Gastrioceratea and Agathiceratea on the other, had a common root, yet his last "phylum" Beloceratea, consists merely of some discoidal genera of the Prolecanitida and other families. Since Arthaber united in the same family the Devonian *Beloceras* and the Triassic *Sageceras*, which are not even morphic equivalents, the concluding sentence of his paper is particularly instructive, and shows that he for one did not appreciate the "far-reaching convergence" of forms.

4. *Wedekind and Schindewolf*. In 1918 appeared Wedekind's very important work 'Genera der Palæoammonoidea'. A threefold division of the ammonoids into Palæo-, Meso- and Neo-ammonoidea was proposed on the basis of the chief modifications of the suture-line. The last division, with the two sub-orders Psiloceracea and Harpoceracea, appears to be based on an inadequate knowledge of the host of post-Triassic ammonites, and must be rejected at once.

Schindewolf's (1923) later attempt to elaborate Wedekind's

scheme was equally unsuccessful, since he can have known but a few groups of Neo-ammonoidea. A classification of the enormously complex series of Jurassic and Cretaceous ammonites based either on the incisions in the external saddles, which may be variable on opposite sides in the same individual, or on the relative positions of successive lobes at the umbilical suture, which are variable in evolute and involute forms of the same species-group, is obviously not acceptable; but Wedekind's *Meso-ammonoidea* are an even more artificial division. Indeed, in 1923, Schindewolf wrote that the *Meso-ammonoidea* did not constitute a homogeneous group, but were polyphyletic. Taking the position of the siphuncle, whether constant or variable, as the fundamental character in the classification of Ammonoidea, Schindewolf concluded that the *Meso-ammonoidea* of Wedekind mainly comprised descendants of Clymenids, and only a few immoto-siphonate Goniatitids (*e.g.* *Pronorites*, *Pro-pinacoceras*, *Daraelites*, etc.). Thus he was forced to separate closely connected stocks; and, like previous attempts of numerous other authors, his classification (elaborated in later papers, 1931, 1932) failed merely because a single character was relied on. For the same reason it is also necessary to reject Wedekind's subdivision of the Carboniferous goniatites, according to three types of radial line, into descendants of Tornoceratidæ (the Middle Carboniferous "Girtyoceratinæ"), of the Cheiloceratid genus "*Brancoceras*" ("Glyphioceratidæ"), and derivatives of Prolobitacea (Gastrioceratidæ).

The change during ontogeny in the position of the siphuncle, from internal to external, said to be characteristic of most of the *Meso*- and all the *Neo-ammonoidea* has been fully discussed in another paper.¹ The older divisions, Goniatitidæ, Ceratitidæ, and Ammonitidæ, used in a family sense, were not more objectionable or more meaningless than the equally overlapping terms Palæo-, Meso-, and Neo-ammonoidea.

In the fifth German edition of Zittel's 'Grundzüge der Paläontologie' (1921), Wedekind's classification of the goniatites is partly adopted, but there are no larger divisions of the Ammonoidea. We shall have occasion to criticize in the following pages the heterogeneous assemblages included in some of the twenty-three families therein recognized (*e.g.* Noritidæ, Medlicottidæ, etc.). Neither this classification, nor that of J. Perrin Smith in the English edition of the same work, or

¹ "Evolution of the Cephalopoda." 'Biol. Reviews', October, 1933, p. 430.

his latest attempts at a systematic simplification (1927, p. 21) can be adopted here.

5. *J. Perrin Smith*. In a remarkable posthumous work, published two years after his death, J. P. Smith (1932) gave a classification of Triassic ammonoids and their forerunners which might be thought to represent a welcome and up-to-date basis for a catalogue like the present. But I am in complete disagreement with the methods adopted by this author—*i. e.* a more or less mechanical application of the biogenetic law; and since I have given my reasons for this disagreement elsewhere,¹ it may suffice to refer the reader to what J. P. Smith wrote on p. 33: "In recent years paleontologists have been prone to derive all Jurassic and Cretaceous ammonites from the *Phylloceras* stock, although they fail to show in their development any reminiscences of either Xenodiscidæ or *Phylloceras*. It is rather remarkable that these Jurassic and Cretaceous forms should have lost their ancestral history so utterly, while *Phylloceras* should have retained it so closely expressed. The writer has always had very grave doubts as to the correctness of the commonly accepted idea, but this must be decided by students of Jurassic and Cretaceous genera." Now, if there is one thing universally agreed, it is this derivation, in spite of what recapitulation may say. Unfortunately, there are not many formations beyond the Alpine Hettangian that have yielded so many ammonites in such perfect condition, stratigraphical order, and especially such complete passage-forms between the different groups; but if successive ammonite faunas were known in equal detail from other and especially Mediterranean formations, it would not now be necessary to acknowledge as true what Abel wrote in 1921 concerning the unfortunate attempts at grouping the Ammonoidea.

6. *M. Schmidt*. Since one objection to the classifications hitherto discussed has been the linking of Triassic stocks direct with such Devonian families as Gephuroceratidæ and Agoniatitidæ, the phylogenetic scheme of Carboniferous and Permian Ammonoidea given by M. Schmidt (1925) offers greater attraction. No doubt modifications of this scheme will be necessary, and Wedekind (1924) criticized the same author's work; it may also be advisable to recognize more root-stocks than the single *Aganides* of H. Schmidt's genealogical tree, but on the whole the scheme brings out well the derivation of the Permian stocks

¹ Spath, 1932. See also 'Paläontologisches Zentralblatt', vol. iii, 1933, p. 345 (No. 1015).

from the two main Carboniferous groups: Prolecanitida and Goniatitida. Whether the former have any connection with the Neo-Devonian Pharciceratidæ—already rather specialized—need not now be considered; nor it is necessary to inquire exactly how the Pronoritidæ are derived from the Prolecanitidæ, or whether the numerous branches of the Goniatitidæ in Schmidt's scheme are correctly inter-connected. But although the derivatives of the Pronoritid root-stock, such as Medlicottidæ and Sageceratidæ, described below, are more or less universally recognized, there is, as yet, great diversity of opinion as to the connection of the other two early Triassic stocks (Ophicera-tidæ and Otoceratidæ) with the Goniatitid branches.

7. *Arabu*. The attempt at a new classification of Palæozoic Ammonoidea put forward by N. Arabu (1933) must be discussed, since it is the most recent, and therefore might be assumed to be the most up-to-date. This author considers that general shape, ornamentation and length of the body-chamber are of minor importance, and that even ontogenetic evidence—always difficult to obtain—is often doubtful; a classification should therefore be based essentially on the suture-line. Unfortunately this has misled him as much as it did Hyatt before him, and there is scarcely a Triassic family that is here adopted, either in Arabu's definition, or in the original meaning of Arthaber or J. P. Smith. I thus believe this author to be entirely wrong when he derives the majority of Triassic genera from *Gastrioceras* and *Glyphioceras*, the latter, in his opinion, having given rise to the "Clionitidæ" and "Ceratitidæ", which are said to include, themselves, the great majority of Triassic ammonoids.

(c) THE ANCESTORS OF THE TRIASSIC AMMONOIDS.

It has been seen that only the Pronoritidæ (of the larger family Prolecanitidæ) and the Goniatitidæ need be considered in our search for the ancestors of the Triassic ammonoids. The former leads directly to the Medlicottidæ, described below, a specialized branch, with the genera *Uddenites*, Böse (1917), and *Prouddenites*, Miller (1930), as transitional groups. J. P. Smith (1903, p. 41), describing *Pronorites*, Mojsisovics, as the ancestor of a large number of genera occurring in the Permian and Trias, considered "*Paraprolecanites*" to be the family radicle of Pronoritidæ, and included in this family both *Sicanites* and *Propinacoceras*—genera already referred by Karpinsky (1889, p. 45) to the Medlicottidæ. On the other hand, *Daræelites*, Gemmellaro, which had been included in Noritidæ by Hyatt

(1900, p. 563) and J. P. Smith (1903, p. 24), and in Prolecanitidæ by Karpinsky (1889, p. 45) and as recently as 1917 by Böse (p. 51), seems to me to be more appropriately attached to *Pronorites* and "*Paraprolecanites*" than to the restricted (Carboniferous) Prolecanitidæ with undivided lobes.

Now the Medicottidæ and the genus *Episageceras*, Noetling, undoubtedly ranged from the Permian into the Trias. It is doubtful, however, whether the Pronoritidæ themselves also persisted into the Mesozoic; and certainly there is no connection between the Pronoritidæ and the Noritidæ, which is based on the Anisian genus *Norites*, Mojsisovics. The doubtful Carboniferous genus *Schuchertites*, J. Perrin Smith, at first considered to be a specialized offshoot of Prolecanitidæ (or of Pronoritinae in M. Schmidt, 1925) and foreshadowing the later *Medlicottia*, is here believed to be a Cretaceous *Engonoceras*. It may be safely ignored, but should serve as a warning. Clearly, also, *Ambites*, Waagen, a Gyronitid, has nothing to do with *Albanites*, Arthaber, 1909 (= "*Pronorites*", Arthaber, 1911, and Welter, 1922), and cannot be considered a transition between Pronoritidæ and Noritidæ. It will also be shown in the following pages that *Norites* itself is not connected with certain Upper Triassic stocks, like Carnitids or Pinacoceratids, while *Sageceras*, Mojsisovics, a genus still commonly referred to "*Beloceratidæ*", is probably a similarly discoidal and multisellate development of a Sicanitid stock. Both Medicottidæ and Sageceratidæ, as here understood, can then be reasonably connected with Pronoritids, but it is far more doubtful whether the remaining two Eo-triassic families, Otoceratidæ and Ophiceratidæ, are also to be attached to some Prolecanitid branch or to the second Palæozoic root-stock above mentioned, namely, the Goniatiidæ. I previously (1930, p. 13) spoke of the Ophiceratidæ as probably direct developments of that Prolecanitid stock which also gave rise to the three upper Permian families, Paralecanitidæ, Paraceltitidæ and Xenodiscidæ (s.s.). I visualized a persisting, unornamented, and evolute main Prolecanitid stock existing side by side with the Pronoritidæ, as shown in J. P. Smith's table (1903, pl. i); but H. Schmidt's scheme (1925, p. 522) may give a truer picture of the evolution of the Prolecanitidæ; and the few sutural elements of the Ophiceratidæ (and their Permian forerunners) as well as the similarly simple, ceratitic suture-line of the early Otoceratids does not exclude the possibility that their origin has to be looked for in the second, main, Palæozoic stock, i.e. the Goniatiidæ.

The Goniatitidæ in the restricted sense¹ with the Homoceratinae (including the genera ranging themselves round *Homoceras*, Hyatt *emend.* Wedekind, such as *Reticuloceras*, Bisat, *Cravenoceras*, Bisat, ? *Nuculoceras*, Bisat, and ? *Homoceratoides*, Bisat) are too far removed in time from the Permo-Triassic families here discussed to be considered as ancestral stocks; and the Gonioloboceratidæ (comprising the genera *Gonioloboceras*, Hyatt, *Milleroceras*, Hyatt, *Gurleyoceras*, Miller and *Dryochoceras*, Morgan) are also remote, like the (unnecessary) "Neoicoceratidæ". But the Gastrioceratidæ, Schistoceratidæ and Dimorphoceratidæ, undoubtedly related to the same main Goniatitid stock, have all given rise to Permian families. Even if there is nothing in the resemblance of a young Tropitid to the coronate *Gastrioceras*, as I pointed out recently (1933, p. 448), or of the galeate **Strigogoniates**, gen. nov.,² to *Otoceras*, yet

¹ Goniatitidæ in the restricted sense includes *Goniatites*, de Haan (*s.s.* = *Glyphioceras*, section I, of Hyatt = *Sphenoceras*, Foord); *Nautellipsites*, Parkinson (genotype: *Ellipsolites oratus*, J. Sowerby, 1813, p. 83, pl. xxxvii); *Glyphioceras*, Hyatt (= section II, of Hyatt = *Beyrichoceras*, Foord); *Munsteroceras*, Hyatt; *Paraglyphioceras*, Bruning; *Neoglyphioceras*, Bruning; *Lusitanoceras*, Sousa; *Osmanoceras*, Kittl; ? *Girtyoceras*, Wedekind (= *Adelphoceras*, Girty, *non* Barrande); *Eumorphoceras*, Girty; ? *Sagittoceras*, Hind; *Beyrichoceratoides*, Bisat; and some more doubtful groups, like *Nomismoceras*, Hyatt, *Wiedeyoceras*, Miller, and *Sudetoceras*, Patteisky. Foord (1903, p. 222) considered that Hyatt's two sections of '*Glyphioceras*' (of which Foord and Crick, in 1897, p. 154, had selected the types) were unnamed, but, contrary to nomenclatorial ruling, applied sub-generic designations to both, instead of restricting *Glyphioceras* to the section (*obtusum* group) that was not covered by *Goniatites s.s.* Haan *emend.* Haug (1898, p. 26, = *sphaericus* group). J. Sowerby's *Ellipsolites oratus* (*non* *Ellipsolithes*, Montfort, 1808), wrongly identified by Foord with "*Beyrichoceras*" *obtusum*, Phillips sp., was taken by Parkinson (1822, pp. 164 and 233) as type of his genus *Nautellipsites*, which has to be resuscitated. *Nautellipsites* is not identical with *Munsteroceras*, Hyatt, as H. Schmidt (1925, p. 543) holds.

² GENOTYPE. *Glyphioceras angulatum*, Haniel, p. 51, text-figs. 11, 12, p. 52. Lower Permian.

DIAGNOSIS. Galeatiform, rather involute oxycones, with suture-line resembling that of *Gastrioceras* and strigation tending to disappear on sides.

REMARKS. This genus may include *Gastrioceras* (*Girtyites*) *liui* Grabau (1924, p. 478, text-fig. 302), believed to be identical with *Paracellites pseudopalinus*, Frech (in Richthofen [v], 1911, p. 190, no. 6), but its inclusion among the Gastrioceratids is doubtful, as is that of *Andersonoceras*, Grabau, with its whorl-shape so curiously foreshadowing the Otoceratids. *Gastrioceras zitteli*, Gemmellaro, is transitional between *Paragastrioceras* (= '*Girtyites*') and *Strigogoniates*.

the last goniatite, *i. e.* *Pseudogastrioceras abichianum* (Müller), generally referred to *Gastrioceras*, was a contemporary of some true Otoceratids. *Pseudogastrioceras* is related to *Paragastrioceras*, and the spiral striation of both makes it improbable that any Lower Triassic stock was descended from the *Gastrioceratidæ*.

The *Dimorphoceratidæ* (including such Carboniferous genera as *Dimorphoceras*, Hyatt; *Anthracoceras*, Frech; *Neodimorphoceras*, Schmidt; *Trizonoceras*, Girty; *Entogonites*, Kittl) are generally accepted to be the forerunners of the Permian *Thalassoceratidæ* (which do not include *Paraceltites* put here by Hyatt). As mentioned below, neither *Ussuria* nor *Acrochordiceras* are believed to be derived from the *Thalassoceratidæ*, since they can be much more naturally attached to certain Lower Triassic groups; and the configuration of the external lobe alone seems to afford a proof that none of the Otoceratids or Ophiceratids was descended from *Thalassoceras*.

The *Schistoceratidæ*, derived by way of *Paralegoceras* (including "*Metalegoceras*", Schindewolf) from the *Gastrioceratidæ*, probably gave rise to the Permian families *Cyclolobidæ* and *Popanoceratidæ*, as J. P. Smith held (1927, p. 45). But I can see nothing in the Lower Trias that could in the least be considered to connect the *Cyclolobidæ* with the *Arcestidæ*, however close the external resemblance; and still less justifiable seems to me Arabu's linking of *Monophyllites* with *Paralegoceras*, when the earliest *Monophyllitids* are so intimately related to certain Lower Triassic ceratites.

The *Agathiceratidæ*¹ also cannot be directly connected with any of the ceratitic Lower Triassic families here discussed, although J. P. Smith thought *Adrianites* to be "the probable branch of the *Agathicerata* that gave rise to the true *Arcestidæ* and the *Cladiscitidæ*". According to Schindewolf, *Agathiceras*, with its siphuncle internal for a few whorls in some species, but not in others ("*Pseudagathiceras*"), continued the *Clymenid* stock. This is said to have shown great expansion in the Triassic; whereas conversely, the goniatitic stock, still dominant in the Permian, gradually disappeared during the Trias. I have shown elsewhere how untenable is this theory, put forward on the strength of a few isolated observations and by the undue stressing of one extremely variable character. The treatment

¹ The genus *Hoffmannia*, Gemmellaro, may well be kept apart in a separate sub-family *Hoffmanninæ*, as already suggested by Mojsisovics in 1888 (pp. 19, 20, footnote).

of the Agathiceratidæ by Schindewolf must equally be condemned, for the appearance of lobes and saddles at the umbilical suture is also far too insignificant and variable to be of any systematic use.

The Paraceltitidæ I previously (1930, p. 13) described as a specialized branch of the Paralecanitidæ, but I probably wrongly associated with them the ornamented genera *Atsabites* and *Epiglyphioceras*, which on account of their more definitely Paralegoceratoid or Gastrioceratoid suture-lines, may be rather distinct. *Paraceltites* itself is not identical with *Paralecanites*, as Frech held; but the suture-line of, for example, the Guadalupean *P. elegans*, Girty, is so close to that of *Paralecanites sextensis*, Diener, that distinction is based on the ornament alone—scarcely a family character. The smooth *Paralecanites*, then, must be the more primitive, and I would consider it also to be the ancestor of the ornamented *Xenodiscus* and *Xenaspis*, with one more lobe, not to mention the Ophiceratidæ and allied hosts of Eo-triassic ceratites. Unfortunately there are no more connecting links between *Paralecanites* and *Prolecanites* (said to persist to the Middle Coal Measures) than there are between the former and *Nomismoceras*, Haug, or between the Xenodiscids (in Arambur's sense) and *Epiglyphioceras*. Yet J. P. Smith's (1932, p. 39) view of the derivation of *Paralecanites* and allied groups (here included in Xenodiscida, *s.l.*; with Ophiceratidæ and their derivatives, as discussed below) is here adopted as the most probable, even if his identifications of *Paralecanites*, *Xenodiscus*, *Ophiceras*, etc., require correction.

Smith also considered the Hungaritidæ (with *Otoceras*) to be derived from *Prolecanites*, and pointed out that specialization of any given group, either in ornamentation or whorl-shape, did not affect the homogeneity of the super-family Prolecanitoidea. When previously discussing the Otoceratidæ, I already mentioned that they were more correctly placed with the totally different Medlicottids and Sageceratids, as descendants of Prolecanitidæ, than with a globose "Nannitid" stock, as was done by Hyatt; and I mentioned that Frech, in including *Otoceras* in the family Xenodiscidæ (*sensu lato*), also dissociated the Otoceratidæ from the involute Glyphioceratid (= Goniaticid) offshoots.

There is no need here to discuss those later Triassic groups like Tropitidæ, that have wrongly been attached to Goniaticids, or even earlier groups, for they are dealt with in detail in the present volume. They can all be derived much more easily from the Lower Triassic ceratites, to be described below, than

from earlier goniatites; and the Paralecanitinæ seem, indeed, to be the radical stock of all Triassic ammonoids, except a few descendants of Pronoritidæ (see Table I, p. 19). The Paralecanitinæ, however, can on no account be grouped with the true *Lecanites*, Mojsisovics, a dwarf offshoot of an unrelated and comparatively late Triassic stock.

This conservative main stock, the Paralecanitinæ then, is typically unornamented, and remained comparatively evolute, while its modified offshoots were destined to perish. Specialization in oxycone whorl-shape, often associated with a correspondingly increased number of sutural elements, has long been recognized as adaptive and recurring in many unrelated stocks; and few would now classify the Triassic Pinacoceratids with the Devonian *Beloceras*, simply because of external similarity. Another tendency to modify the whorl-shape is correlated with the presence of lateral processes (apophyses) of the mouth-border and with the hyponomic sinus, and produces, first, ventro-lateral edges, with or without grooves, and finally a carinati-sulcate venter resembling that of Lower Liassic Arietitida. Lateral ribbing or spiral fluting and various types of tuberculation are also found already in the Devonian, and it is clear that the occurrence of similar trachyostracous or coronate offshoots in other stocks of higher formations does not indicate genetic affinity. Thus *Aphyllites* and *Mæneceras* in the Middle Devonian, *Aulatornoceras* and *Glatziella* in the Upper Devonian, and *Dimorphoceras* and *Nomismoceras* in the Lower Carboniferous, develop paired external furrows, but are specialized offshoots, whose existence was ephemeral compared with that of the smooth, conservative radicals from which they sprang. The polygyral *Gaudryceras*-like coiling of some of these early offshoots, however, may be an extreme development in one direction, just as the sphærocones of other stocks represent end-forms in the opposite direction.

Table I is an attempt to represent the interconnections of the Palæozoic families here discussed and their Eo-triassic descendants. But no dogmatic value is claimed for the diagram, for the rich faunas of the Permian and Lower Triassic have only recently been made known in detail, and are as yet ignored by those who rashly assert that the Permian system has "no real existence" (Sherlock, 1928, p. 87). On the other hand, there are known doubtful dwarf-developments, generally neglected, or species like "*Parapopanoceras*" *dyadicum*, Haniel (1915, p. 106, pl. lii, fig. 6), from Timor, which, if really Permian, may

profoundly modify our views. On present evidence, however, it seems that the Ophiceratids, after successfully transgressing the border from the Palæozoic to the Mesozoic, showed rapid expansion comparable to the sudden burst of Gephuroceratids in the Upper Devonian of the Domanik, Southern Timan. In that

TABLE I.—*Probable Interrelations of main Palæozoic Ammonoid Families.*



locality there appeared in large numbers depressed and compressed, smooth and ornamented, evolute and involute, rounded, square- or acute-ventered forms, and even highly specialized oxycones. The possibilities of variation were yet greater in their descendants, commonly grouped together as "Meekoceratids", because in these the lobes of the suture-lines began to be modified. A multitude of generic names obscures the essential uniformity of this stock far less than the attempt to connect its various extremes to different Palæozoic homœomorphs.

C. CHRONOLOGY AND STRATIGRAPHY.

(a) THE TRIASSIC SUCCESSION.

It is now almost universally agreed that sediments yielding ammonites of the family Psiloceratidæ, and beds like the White Lias¹ correlated, or in close association, with them are to be included in the Hettangian, or lowest Jurassic. Since Ammonoidea are absent, or at least rare, even in Alpine Rhaetic deposits, and abundant in the succeeding Psiloceratan division, it is often easy to fix the upper limit of the great Triassic formation. Owing to a similar scarcity of Ammonoidea in the Upper Permian, the lower limit of the Trias is also more or less agreed upon, and may, with Mojsisovics, Bittner and Diener, be drawn at the base of the zone of *Otoceras woodwardi* (Griesbach). In the nomenclature of the three great sub-formations of Upper, Middle and Lower Trias (here termed Neo-, Meso-, and Eo-Trias) some disagreement still exists, but the following stages and divisions will here be adopted :

Neo-Trias	{	Rhaetic	{ Eopsiloceratan.
			{ Rhaetitan.
		Norian	{ Pinacoceratan.
			{ Haloritan.
		Carnian	{ Tropitan.
			{ Carnitan.
			{ Trachyceratan.
Meso-Trias [Virglorian]	{	Ladinian	Ceratitan.
		Anisian	{ Paraceratitan.
			{ Beyrichitan.
Eo-Trias [Scythian]	{	Upper Eo-Trias	{ Prohungaritan
			{ Columbitan.
			{ Owenitan.
	{	Lower Eo-Trias	{ Flemingitan.
			{ Gyronitan.
			{ Otoceratan.

It ought to be mentioned that, since the terms Cretaceous and Jurassic are habitually used, no objection can be taken to our preference for the well-established Rhaetic (instead of Rhaetian),

¹ Confused, for instance, in Arkell (1933) with much earlier Neo-triassic, *i. e.* Rhaetic beds on account of the extraordinarily fragmentary nature of the English deposits which, in the absence of ammonites (*e.g.* *Choristoceras* of the *Pteria contorta* beds), cannot be correlated any more exactly than the Permian and earlier Triassic of the same area.

on the one hand, and for Norian (instead of Noric), on the other. Since Cretaceous also has come to mean something entirely different from a mere Chalk formation, the stage names, intended only as labels for a certain period of the geological time-scale, must assume wider meaning with the increase of our knowledge of the episodes within that period. Everybody will agree that Lower Meso-Trias, or Anisian, is more euphonious than "Lower Middle Trias"; and when once the succession is fairly established, a subdivision into ages, according to the dominant, and non-local, ammonite families is desirable, because generally more-or-less universal. Interpretations, however, will vary probably for many years to come, and compared with the Upper Mesozoic the study of the stratigraphy of the Trias is as yet in its infancy. The chronology of the Triassic here proposed, being largely new, is, of course, tentative.

(b) CONTEMPORANEOUS FAUNAL AND STRATAL FACIES.

The objections to the polyhemeral subdivision of the Lias (Spath, 1927, p. 10; 1931, p. 186) apply equally to the Trias; yet the Trias represents a period which probably was considerably longer than the whole of the Jurassic, and is actually less completely known than was the latter when Oppel divided it into some thirty zones. The fauna of Kčira, in Albania, described by Arthaber (1911), and obviously different from the faunas previously known, was considered to show greater resemblance to that of the Asiatic Trias, because it was rich and varied as compared with the impoverished fauna of Muč, in Dalmatia. The last was taken to represent a shallow-water facies, living in conditions of decreasing salinity, which caused the extinction of most of the species. In the writer's opinion, on the contrary, the two faunas are entirely different simply because they are of different dates, although probably belonging to the same Columbitan division. Similarly, Diener (1913, p. 121), while pointing out that the identity of a number of the Albanian species with their Indian prototypes was questionable, yet considered the Kčira fauna to be homotaxial with the *Hedenstræmia* stage of India, but to show a distinct and provincial character. The "impoverished Werfen fauna" was also described as showing a strictly local habit, and stress was laid on the "facies of red limestones" of the Kčira fauna. The characters of the latter, however, like that of the red marbles of Han Bulog and Hallstatt, may be due to subsequent regional metamorphism. It is clear that in Triassic times,

as at any other period, there were distinct marine provinces, and this may account for certain differences in contemporaneous ammonite faunas. Yet, relying on the whole fauna and not on single individuals, it is generally easy to recognize approximately contemporaneous deposits. It is always unsafe to assume that, because a certain fauna seems to an individual observer more advanced than a comparable one from a different locality, it must therefore be of later age. Some species, again, have unexpectedly long ranges, as *Arnioceras semicostatum* in the Lower Lias, or *Anahoplites planus* in the Gault. But until there is considerably more information about detailed sequences in the Trias, and especially its lower beds, the scheme here put forward cannot be considered to be more than an approximation to a more detailed chronology. But I believe that William Smith's fundamental principle of stratigraphy can be applied to the great Triassic formation in much greater detail than has hitherto been attempted.

(c) THE PERMO-TRIASSIC HORIZONS.

1. *Otoceratids, both Permian and Triassic.*

A discussion of the horizons of the Eo-trias may be based on the inter-regional correlation table published by Prof. Perrin Smith in 1914, his table of 1932, and my own scheme of 1930. The *Otoceras* beds listed at the base of the Himalayan Trias are here taken to include only the three zones of *Otoceras woodwardi* (base), of *Episageceras dalailamæ* (middle), and of *Ophiceras tibeticum* (top, see p. 27). The earlier *Prototoceras* of the Djulfa fauna (see p. 65) of Armenia may be uppermost Permian, as correlated by various authors, including Böse (1917); and Bonnet's researches (1911-1919) have shown that it may be immediately pre-*woodwardi*; but according to Stojanow (1909) the Djulfa beds with (a) "*Otoceras*" (*Prototoceras trochoides* (Abich) are followed above by (b) a *Reticularia* zone, (c) the main horizon of "*Gastrioceras*" (*Pseudogastrioceras abichianum* (Moeller), (d) over 30 ft. of unfossiliferous marls, and (e) at the top the horizon of *Popanoceras tschernyschewi*, Stojanow. There are thus altogether five Djulfa horizons. It might be held that *Pseudogastrioceras* shows a suspicious resemblance to the earlier *Paragastrioceras*, Tschernow (= *Girtyites*, Wedekind = the group of *Gastrioceras jossæ*, de Verneuil), and to its allies. Similarly, Stojanow's *Popanoceras* resembles forms of the Meso-permian Sosio beds of Sicily; so that the Djulfa succession could perhaps be taken

to be so complex as to have deceived the different investigators. The Brachiopod beds with *Productus* that follow above (or below) the *Prototoceras* zone, however, are not Triassic; and Bonnet's (1912, p. 1742) work shows that the post-*Prototoceras* age of *Pseudogastriceras abichianum* must be accepted. In this connection it is well to remember that *Prodromites* is as much out of place in the Kinderhook group (Protocanitan age of the Lower Carboniferous) as *Flickia*, Pervinquière, with goniatitic sutures, is in the "Lower Cenomanian". If "biological order" does not agree with observed stratigraphical succession, there can be no doubt that our views of what constitutes "biological order" must be erroneous. Tschernyschew (1902, pp. 668, 710, 716) and Stojanow (1909, pp. 64, 113) have pointed out how unsatisfactory are arguments based on the principle that the stage of evolution attained by certain fossils (in the present case the ceratitic suture-line of *Prototoceras*) can be used for exact dating of the beds in which they occur.

2. The Permian in the Salt Range, etc.

There is thus no evidence to show that the five zones of Djulfa must immediately precede the three zones of the base of the Triassic succession in the Himalayas. Now Arthaber (1911, p. 194) stated that at Djulfa, as in the Salt Range and in the Himalayas, the Lower Trias followed on the Palæozoic without a break and was perfectly conformable with it. It is true that the possibility of non-sequences, so common in the Jurassic and Cretaceous, but rarely associated with noticeable lithological changes, was not considered either by Arthaber or his predecessors. Thus we find Noetling (in Frech, 1901, p. 658) correlating the upper three zones of the Chideru Group, or Upper *Productus* Limestone (namely, the zones of *Euphemus indicus*, of "*Medlicottia*" *wynnei* and of *Bellerophon impressus*), with the three Lower Triassic sub-zones of the *Otoceras* beds above referred to, though he may have been influenced by v. Krafft's (1901, p. 275) identification of "*Medlicottia*" [*Episageceras*] *wynnei* and "*M.*" *primas*, Waagen, with Diener's "*M.*" *dalailamæ*. This is undoubtedly a case of the recurrence of somewhat similar, but not identical, species at different levels; for *E. dalailamæ* does not agree in suture-line with Waagen's *E. wynnei*, and v. Krafft's drawings from the type confirm the difference.

Again, Noetling put the zone of *Cyclolobus oldhami* below the three upper zones just discussed, *i. e.* immediately below

the zone of *Otoceras woodwardi*, which is here taken as the base of the Trias. The only other ammonoids of the Chideru beds, leaving aside the doubtful *Xenodiscus plicatus*, Waagen, are *Stacheoceras priscum* and *S. antiquum* (Waagen). Böse correlated with the *Cyclolobus* zone of the Salt Range the beds of Ajer Mati, in Timor, the fauna of which was described by Rothpletz and Haniel. This also contains *Stacheoceras* similar to the Djulfa "*Popanoceras*"; but forms of that genus in Timor seem to have a wide range.

Böse also put the *Bellerophon* Limestone of the Alps considerably above the Kuling Shales of Spiti, which, according to Bittner and Diener, contain identical forms of *Bellerophon*, but no ammonoids. The mere fact that the Kuling shales are not only followed, but apparently followed with perfect conformity, by the Triassic *Otoceras* beds, does not enable us to date them precisely. The writer follows Böse in provisionally placing the Djulfa Beds above the Upper *Productus* Limestone, and the *Paralecanites* beds of the *Bellerophon* Limestone of the Southern Alps higher still. In any case it is clear that the Upper Permian sequence must be very considerably extended. The succession is probably something like that of the following table :

TABLE II.—Subdivisions of the Permian.

Lowest Trias	<i>Otoceras woodwardi</i>	(Otoceratan)	
Upper-Permian (Neo-Permian)	<i>Paralecanites sextensis</i>	(Alps)	
	<i>Stacheoceras (Popanoceras) tschernyschewi</i>	(Djulfa)	(Protoceratan)
	<i>Pseudogastriceras abichianum</i>		
	<i>Protoceras trochoides</i>		
	<i>Episageceras wynei</i>	Salt Range (Timor)	(Xenapidan)
	<i>Cyclolobus oldhami</i>		
	<i>Xenaspis carbonaria</i>		
Lower Permian (Eo-Permian)	<i>Krafftoceras</i> sp.	Timor (Basleo)	(Waagenoceratan)
		Texas	
	<i>Stacheoceras timoricum</i>	Timor (Bitanni)	
	<i>Daraelites</i> sp.— <i>Waagenoceras dieneri</i>	(Sosio, Texas)	(Marathonitan)
	<i>Perrinites</i> sp.— <i>Prothalassoceras</i> sp.	(Hess formation, Texas)	
	(<i>Artinskia</i> Beds, Artinsk)		
	<i>Uddenites</i> sp.— <i>Marathonites</i> sp.	(Wolfcamp formation, Texas).	

3. *Importance of the Permian System.*

It will be readily seen that Table II will require checking and completing by the results of zonal collecting. Probably it will be necessary to collect in many localities; for the chances are remote of any one section showing more than a portion of the ideal succession. The table will serve, however, to show not only that the Permian is in itself an important system, and of incomparably longer duration than is generally supposed, but that the palæontological break which suggested to the older authors the separation of the Mesozoic from the Palæozoic, like the similar lacuna between the Jurassic and Cretaceous, or between the latter and the Tertiary, is far more fundamental than one would suppose from the few transitional "beds" hitherto discovered. From the occurrence of entirely dissimilar ammonoid faunas in the Djulfa Beds of Armenia, the *Bellerophon* Limestone of the Southern Alps, the Upper *Productus* Limestone of the Salt Range, and the *Cyclolobus* Beds of Timor, we are justified in assuming that they are not contemporaneous, even if we may temporarily be obliged to list them in a wrong order. The lower part of the Upper Permian seems still less completely known, and, with the exception, perhaps, of the *Waagenoceras* beds of the Lower Permian, which Böse (1917, p. 46, Table I), apparently without evidence, correlated with the Lower *Productus* Limestone, the basal part of the formation also is as yet very inadequately represented.

(d) THE LOWER TRIAS.

1. *Supposed Contemporaneous Beds are Heterochronous.*

The Lower Trias in different areas follows on different portions of an incomplete Permian sequence. There will be no need to emphasize here that, like the Permian, the Lower Trias is believed to be fragmentary, even in the most representative localities so far known, such as the Salt Range, or the Himalayas. It follows that our incomplete knowledge of the cephalopod-bearing beds of the Lower Trias and Permian, and the weak representation of marine sediments in the well-explored countries of Europe, have wrongly suggested that these periods were of short duration and comparatively unimportant compared with the Carboniferous below and the Middle and Upper Trias above. As late as 1886 Mojsisovics

(p. 152) listed, as equivalents of the Alpine Werfener Schichten, the Lower Triassic "*Xenodiscus* Beds" of India, the *Meekoceras* Formation of Idaho, and the Olenek Beds of Siberia—really heterochronous formations. Even ten years later, in spite of the subdivision of the Scythian series into stages and sub-stages, and apart from the incorporation of Waagen's classification of the beds of the Salt Range, Mojsisovics's (1896) tables gave a misleading representation of the Lower Trias. Although the latest correlation-scheme by J. P. Smith (1932), already referred to, marks an advance by recognizing *Columbites* and *Tirolites* faunas in the Upper Scythian, and *Meekoceras*, "*Genodiscus*" and *Otoceras* beds as characterizing the lower division, yet the various supposed equivalents, for instance, those of the *Columbites* beds, are still heterochronous formations, as will appear. Like Welter, in his treatment of the Lower Trias of Timor, J. P. Smith failed to realize that the few faunas he described were closely related among themselves, but, together, covered only a portion of Eo-triassic time.

2. *The Three Otoceratan Horizons.*

J. P. Smith, however, was right in considering, with Mojsisovics, that the *Otoceras* beds of the Himalayas (or the "Gangetic sub-stage") were earlier than any other known Triassic formation. The three horizons that can be distinguished in this Otoceratan division have already been mentioned, and it is important to note that Diener (1913, p. 119) stated: "In the classical section of the Shalshal Cliff the characteristic species of *Ophiceras* are associated with *Otoceras* in the same bed, and *Otoceras* itself, according to Frech and Noetling, is met with in still higher beds, above the top of its main layer." Though Diener (1909, p. 166) objected that in stratigraphical importance Noetling's "zones" scarcely equalled Buckman's "hemeræ", the fact that the faunas are restricted to thin beds cannot influence the question as to their existence at three successive periods. In East Greenland also, *Otoceras* has now been found to overlap *Ophiceras*.

3. *Passage from Otoceratan to Gyronitan.*

If we now analyse the fauna of the *Ophiceras* layer or highest of these zones, we find that it has scarcely a single species in common with the *Proptychites*-beds of the Ussuri district, the fauna of which had at first been correlated by Diener (1895*a*, p. 175)

TABLE III.—Subdivisions of the Lower Trias.

Divisions.		Zones.	Equivalents.
Upper Eo-trias	Prohungaritan (Olenikitan ?)	. . . . .	{ Upper <i>Arctoceras</i> Beds, Spitsbergen. Olenek Beds, Siberia (<i>partim</i>). { <i>P. middlemissi</i> Beds, Kashmir. <i>Subcolumbites</i> Beds, Albania, Timor. <i>Columbites</i> Beds, Idaho. <i>Tirolites</i> Beds, Alps, etc., Idaho. { <i>Anasibirites</i> Beds, Timor, Utah. Chocolate Limestone, Byans ? { Upper Ceratite Limestone, Salt Range. <i>Kashmirites</i> Beds, Kashmir, Timor. <i>Meekoceras</i> Beds, Timor, Idaho, California. Timor, Himalayas, W. America. Ceratite Sandstone, Salt Range. Upper Ceratite Marls, " " Middle " " " Lower " " " { Lower Ceratite Limestone, Salt Range. Ussuri Beds ? <i>Proptegichites</i> Beds, E. Green- land.
	Columbitan	. . . . .	{ <i>Columbites</i> { <i>Tirolites</i>
	Owenitan	. . . . .	{ <i>Anasibirites</i> { <i>Owenites</i> <i>Pseudosagoceras</i> { <i>Flemingites flemingianus</i> { <i>Koninckites volutus</i> { " <i>Celtites</i> " <i>fallax</i> <i>Prionolobus rotundatus</i>
	Gyronitan	. . . . .	{ " <i>Celtites</i> " <i>radiosus</i>
Lower Eo-trias			
	Otoceratan	. . . . .	{ <i>Ophiceras tibeticum</i> { <i>Episagoceras dalailamæ</i> <i>Otoceras woodwardi</i>
			{ <i>Ophiceras</i> Beds, Kashmir, E. Greenland. <i>Otoceras</i> Beds, Himalayas, E. Greenland.

with that of the Himalayan *Otoceras* Beds. In fact, it seems probable that not even the *Ophiceras* layer of Pastannah, in Kashmir, is synchronous with the zone of *Ophiceras tibeticum* at Painkhanda; for Diener (1913, p. 15) stated that the typical form of *O. sakuntala*, Diener, the commonest form of the *tibeticum* zone of the Himalayas, was very rare in Kashmir, where, however, the genus "*Xenodiscus*" played an equally important part (p. 117). If, however, "*Xenodiscus*" *himalayanus*, said to be rather common in Kashmir, has been misidentified (see below, p. 82), it is useless to state that Griesbach's type from the Shalshal Cliff is preserved in the same slab of limestone as an example of *Otoceras woodwardi* (Griesbach). There must be passage beds between the early true *Ophiceras* Beds and Noetling's zone of "*Celtites radiosus*".

"*Xenodiscus radians*," Waagen, is said to have been found by Krafft in the *tibeticum* ("*sakuntala*") zone of Spiti, but the early *Glyptophiceras* are often difficult to distinguish from somewhat homœomorphous *Xenodiscoides* that occur in the overlying "*Meekoceras*" and *Hedenstræmia* Beds. There appears to be no doubt that the Gyronitan and Flemingitan ages include a number of horizons that cannot yet be definitely listed. In the *Proptychites* Beds of Ussuri, which, as has already been mentioned, include various deposits later than the Otoceratan age, *Proptychites hiemalis* and "*Meekoceras*" *varaha* have been described by Diener as the leading fossils, the former being particularly abundant. A comparable *Proptychites* is said to have been found in the *Ophiceras* Beds, but typical species of this genus do not occur higher than the Ceratite Marls of the Salt Range, the maximum being in the Lower Ceratite Limestone. "*Dinarites*" *minutus*, Waagen, also is said to be common to the Ussuri beds and the Ceratite Marls, but I (1921, p. 302) have pointed out that the Ussuri, like the Spitsbergen, forms of this genus [*Xenoceltites*], also Waagen's "*Dinarites*" *evolutus*, belong to a much higher division, and thanks to the researches of A. A. L. Mathews we now know it to occur in the *Columbites* Beds. Frech (1901, p. 660) already had assumed that two horizons were represented in the Ussuri fauna, namely, forms belonging to the *Ophiceras* Zone, and a younger fauna, which he correlated with the Indian "*Meekoceras*" Beds. In reality there may be a horizon, characterized by *Pachyproptychites otoceratoides* (Diener), special to this area and absent or not yet recognized in India, together with beds also represented in the upper four ages of the Lower

Triassic sequence of other areas, but the horizons need not be consecutive. In Timor, also, an example of *Ussuria*, comparable to the Siberian form, has been found in the *Owenites* Beds (Owenitan or Meekoceratan division).

4. *Gyronitan* and *Flemingitan* in the Salt Range.

The Lower Ceratite Limestone of the Salt Range was considered by Noetling to represent one zone (zone of "*Celtites*" *radius*) and, together with the zone of *Prionolobus rotundatus*—equivalent to the Lower Ceratite Marls—was correlated with the *Meekoceras* Beds (zone of "*M.*" *markhami*) of the Himalayas.

It has already been mentioned that, whereas in the Himalayas the *Otoceras* Beds occur at the base of the "*Meekoceras*"-bearing strata, the Lower Ceratite Limestone, the lowest Triassic Bed of the Salt Range, was assumed by Waagen, on palæontological grounds, to be of later age. This implied a break at the top of the Upper Permian *Productus* Limestone in the Salt Range—a view hotly contested by Noetling (1901, p. 109), who, as has already been seen, correlated the *Otoceras* Beds with the Upper Permian. The following six zones were recognized by Noetling (in Frech, 1905, p. 164) in the Ceratite Beds of the Salt Range, and were at first taken by J. P. Smith to represent the complete succession up to the top of the Lower Trias; the highest zone (vi) has even been referred to the Middle Trias, in spite of the fact that it does not contain a single Meso-triassic ammonite.

vi. Zone of *Stephanites superbis*, Waagen (Upper Ceratite Limestone), with *Prionites tuberculatus*, Waagen; *Sibirites ibex*, *S. angulatus* [sic], Waagen.

v. Zone of *Flemingites flemingianus*, de Koninck, sp. (Ceratite Sandstone), with *Hedenstræmia mojsisovicsi*, Diener; "*Aspidites*" *kingianus*, "*Koninckites*" *gigas*, "*Aspidites*" *superbus*, Waagen.

iv. Zone of "*Koninckites*" *volutus*, Waagen (Upper Ceratite Marls), with "*Prionolobus*" *undatus*, "*P.*" *ophioneus*, Waagen; *P. atavus*, Waagen; *Proptychites lawrencianus*, Waagen [sic], *P. undatus*, *P. discoides*, Waagen; *Kingites declivis*, Waagen; "*Aspidites*" *superbus*, mut. *præcursor*, Frech; *Flemingites glaber*, Waagen; *Episageceras latidorsatum*, *Pseudosageceras multilobatum*, Noetling.

iii. Zone of "*Celtites*" *fallax* (Koken MS.), Frech (Middle Ceratite Marls), with "*Xenodiscus perplicatus* var. *involuta*", Frech.

ii. Zone of *Prionolobus rotundatus*, Waagen (Lower Ceratite Marls), with *Prionolobus plicatus*, Waagen; *Gyronites frequens*, *G. vermiformis*, Waagen; *Flemingites prænuntius*, Frech; *Clypites evolvens*, Waagen; "*Aspidites*" *discus*, Waagen; *Pseudosageceras multilobatum*, Noetling.

i. Zone of "*Celtites*" *radiosus* (Koken MS.), Frech (Lower Ceratite Limestone), with *Gyronites frequens*, Waagen; *Ambites discus*, Waagen; "*Prionolobus*" *sequens*, Waagen; "*Celtites fortis*" (Koken MS.), Frech.

It will be seen that although this scheme differs somewhat from the ammonite sequence recorded by Waagen, it emphasizes the overlap of *Gyronites* and *Flemingites*. Caution is necessary in analysing these Lower Triassic faunas; for while Waagen may have been incorrect in stating that *Prionolobus plicatus* was confined to the middle division of the Lower Ceratite Limestone, Noetling may have misidentified the form he listed under the same name from the Lower Ceratite Marls. In any case, the *Gyronites* Beds are capable of subdivision, and if I here adopt some of Waagen's records that are open to criticism, it is done chiefly to extend the time-scale, and to give a truer picture of the incompleteness of the known sequences of the Lower Trias.

It seems possible, then, to subdivide the Gyronitan age into a number of zones, and to separate it from the *tibeticum* zone by at least one passage zone, which thus bridges the gap between the *Ophiceras* of the Otoceratan age and the so-called "*Ophiceras*" of the lowest Gyronitan. That is to say, the Salt Range sequence now stands revealed as including six more-or-less closely related zones which, however, do not comprise either the Lower or the upper part of the Eo-triassic, but merely a portion taken out of the middle.

5. The Eo-triassic of Timor.

The Timor forms of "*Vishnuites*", recorded by Welter (1922, p. 137), are entirely different from the Indian types, and of later age; nor can Welter's "*Otoceras*" sp. ind., be accepted, for it was associated with "*Prenkites*", and the statement that "the genus *Prenkites*, in Timor, occurred in the lowest

Trias, but in Albania did not appear till the *Hedenstræmia* fauna " is quite inadmissible. As will be shown below, Welter's form is not a *Prenkites*, even if it is a Columbitid, and its resemblance to *Anotoceras nala* (Diener) from the lowest *Otoceras* Beds is as superficial as the resemblance to certain late Triassic *Tropites*. The association of the Timor ammonites with numerous "*Meekoceras*", including a form referred to *M. mushbachanum*, White, and the presence in the lowest beds of *Prionobolus*, *Paranorites*, and *Flemingites*, shows that the forms considered by Welter to be of lowest Eo-triassic age include nothing below the Middle of the Flemingitan division. Detailed subdivision of the Flemingitan is, perhaps, not advisable at present. The limestones with "*Ophiceras*" *crassicostatum*, Welter, recorded from Timor, probably belong to the top of this division, and are followed by higher beds, perhaps continuous up into the Anisian.

6. The Higher Beds of the Eo-trias.

Noetling included the Upper Ceratite Limestone in a "*Stephanites* zone", but this may be separated from the "*flemingianus* bed" by a considerable break. Waagen, however, recorded his *Xenoceltites* ("*Dinarites*") *evolutus*, also apparently of not earlier than "Stephanitan" age, from the topmost beds of the Ceratite Sandstone (said to be transitional to the Upper Ceratite Limestone), so that the faunal gap may not correspond with a lithological break. When describing some Spitsbergen ammonites (1921, pp. 302, 350), I recorded numerous examples of the genus *Xenoceltites* already referred to, comparable to "*Dinarites*" *evolutus*, Waagen, and to "*Ceratites*" *minutus*, Diener (non *Dinarites minutus*, Waagen), from the Ussuri beds. Now these Spitsbergen forms, with "*Anasibirites*", "*Keyserlingites*" (= *Wasatchites*), *Prionites* and *Arctoprionites* were confined to the same nodule bed, whilst *Arctoceras* ranged up into the Lower *Posidonomya* Shales. But *Xenoceltites*-like forms, resembling the Spitsbergen "*Dinarites*", also a doubtful "*Keyserlingites*", have been recorded from as high as the Californian *Parapopanoceras* beds (with *Acrochordiceras*) of the base of the Middle Trias, while apparently corresponding Utah beds were stated to be below the *Tirolites* zone. There can thus be no doubt that the various *Anasibirites*- and *Prionites*-bearing beds of different localities are not contemporaneous, and that a number of

additional horizons may eventually be recognized in the Owenitan and Columbitan ages. For the present purpose it may suffice to point out that there is a considerable gap between the Flemingitan Ceratite Sandstone on the one hand, and on the other hand the late Owenitan Upper Ceratite Limestone, and that there may be yet other "*Stephanites* beds" which, while said to contain "*Acrochordiceras*", are well below the *Parapopanoceras* beds at the base of the Anisian.

It follows that the placing of the Upper Ceratite Limestone or of the "zone of *Stephanites superbus*" at the top of the Lower Trias has always been erroneous. The "*Stephanitan* age" corresponds to the Upper Owenitan, and is earlier, not later than the Columbitan. But it has yet to be proved that the Upper Ceratite Limestone is of the same age at all the localities in the Salt Range; and the interpretation of *Stephanites* at present is dependent on its occurrences at Djulfa (Stoyanow, 1910) and at Horizon I of the Guryul Ravine, Kashmir (Diener, 1913), where it was found together with *Kashmirites*. In Timor, on the other hand, the white limestone, made up almost entirely of *Anasibirites multiformis* (with only two small *Owenites*), is distinct from the presumably earlier, yellow and brown *Kashmirites* (and *Meekoceras*) Beds which can be correlated by the abundant occurrence in them of large forms of *Owenites*. In Utah, the *Anasibirites* Beds likewise are from 37 to 100 ft. above the *Meekoceras* Beds, but the Spitsbergen fauna, mentioned above, is probably a little later, in spite of the occurrence of *Wasatchites* (formerly *Keyserlingites*) and *Gurleyites* (previously *Anasibirites*).

For the present it seems safer not to be influenced by the apparently high evolutionary level of Waagen's *Stephanitids* and "*Acrochordiceras*". In any case the Hydasopian, if equivalent to the Upper Ceratite Limestone (Mojsisovics, Waagen and Diener, 1895, p. 1279), cannot be included in the Middle Trias in view of the dominant *Anasibirites*, *Kashmirites*, *Prionites*, etc., of that formation.

7. The Uppermost Eo-trias.

On the other hand, the uppermost beds of the Eo-trias are as yet very incompletely known, and the use of the term Prohungaritan (or Olenikitan) is provisional, for the *Olenikites* especially may yet be found to belong to the Columbitan,

together with *Keyserlingites*, although its derivative *Durgaites* is a characteristic element of the Lowest Anisian. J. P. Smith (1932, p. 20), indeed, included in one *Columbites* zone all the more important Upper Eo-triassic faunas known. But apart perhaps from the Spitsbergen faunas, the sequence of which is unfortunately too incompletely known, these Upper Eo-triassic faunas are all distinguished from the succeeding Anisian faunas by the most striking differences. Misidentification, for instance, of species of *Eophyllites* and *Pseudharpoceras* may make this gap appear slighter in J. P. Smith's table than it really is, but even among the Upper Eo-triassic faunas listed there are only two that are really comparable. These are the *Albanites* and *Subcolumbites* faunas of Timor and Albania; but the latter, again, is difficult to interpret, although I suspect that the apparent mixture of elements of various Upper Eo-triassic elements is due to misidentifications. Thus while *Ophiceras* and *Proptychites* are out of question, even *Anasibirites* is too early to be represented; and there is certainly nothing in the large Albanian collections before me that suggests a pre-Columbitan or even Columbitan age in the strict sense.

Although the *Albanites-Subcolumbites* faunas of Albania and Timor are probably later than the *Columbites* fauna of Idaho, there is little to correlate them with either the "*Hungarites*" *middlemissi* assemblage of Kashmir or the Arctic faunas of presumably equivalent age. I agree with Diener that the distribution of the continents and seas in Eo-triassic times was probably not unlike that of the present day, except for the extended Tethys, and I have shown elsewhere (1930, p. 87) that ammonite faunas, when they are strictly contemporaneous, are remarkably similar, wherever they occur. Thus with the *Otoceras-Ophiceras* and *Proptychites* faunas of East Greenland or the Anisian *Gymnotoceras* and *Ptychites* faunas of Spitsbergen, there is no difficulty in correlation; yet the Olenek fauna defies an attempt to place it now, almost as much as when Mojsisovics took it to be older rather than younger than the *Arctoceras polare* assemblage of Spitsbergen.

It would even be risky to assume that the slight differences between such species as *Wasatchites tridentinus* and *Keyserlingites middendorffi*, or between *Prosphingites spathi* and *P. czekanowskii* indicate only a small time-gap between the Spitsbergen and Olenek faunas. But while it may be as impossible to prove that they are equivalent to the Columbitan, as it is to demonstrate that they are later, I feel that there is need for at

least one additional horizon at the top of the Eo-trias. I am not impressed by the fact that the lowest Anisian *Parapanoceras* Beds of California are 800 ft. above the *Meekoceras* horizon, while in Idaho the *Tirolites* and *Columbites* zones follow within 255 ft. of the corresponding *Meekoceras* Beds. I am merely relying on the obvious differences between the lowest Anisian and the highest Scythian faunas so far known, and the only difficulty is to find a name for this time interval that will prove sufficiently accurate to serve for a label, even if it is not the best that could ultimately be proposed.

(e) THE MIDDLE TRIAS.

1. *Present Classifications Inadequate.*

The correlation of the beds of the Middle Trias is as unsatisfactory as that of the Scythian. Four zones are generally recognized, namely :

- iv. Zone of *Protrachyceras archelaus*.
- iii. ,, ,, *reitzi*.
- ii. ,, *Ceratites trinodosus*.
- i. ,, ,, *binodosus*.

To these must be added the *Beyrichites* Beds of Ismid, occurring below the zone of *Ceratites binodosus*, and the *Parapanoceras* Beds of California, placed by J. Perrin Smith as an additional zone below *Beyrichites*. This is inadequate to represent the two long periods of the Anisian and Ladinian, or to convey an idea of the successions of ammonite faunas during that interval. Unfortunately, since our knowledge of the successions is still very incomplete, it has been necessary, as in Table III, to insert in Table IV a number of beds more-or-less on surmise. It is hoped that this tentative classification may lead to a revision of the critical sections and more detailed correlation, and ultimately be corrected by the results obtained.

2. *The Correlation of the German Upper Muschelkalk.*

To correlate the *Ceratites* Beds of the Germanic Upper Muschelkalk with the whole of the Alpine Ladinian is almost certainly incorrect. Philippi (1901, pp. 15, 21), whilst deriving the "nodosi" of the Upper Muschelkalk from the Alpine *binodosus* group, pointed out that the inner whorls of large examples of *Ceratites* from younger beds were more primitive than the earlier forms, *i. e.* that they did not conform with the

TABLE IV.—Subdivisions of the Middle Trias.

Age.	Zones.	Equivalents.
Upper Meso-trias (Ladinian)	Ceratitan	(<i>Subtridentinus</i> Beds (Wengen Beds, Fured Lst). <i>Aplococeras avisanum</i> Beds, Esino Lst. Marmolata Lst.
	<div> <div> <i>archelaus</i></div> <div> <i>reitzi</i></div> </div>	<div> <div> <i>Ceratites semipartitus</i> <i>nodosus</i> <i>spinosus</i> <i>compressus</i> <i>atarus</i> <i>tornquisti</i> (Buchenstein Beds). </div> <div> <i>Protrachyceras</i> Beds, Mora d'Ebro, Bladen. <i>Analcites</i> Beds, Nevada, upper part. <i>Trinodosus</i> Beds, Alps, Bosnia, etc.; upper part, Schaumkalk. </div> </div>
Lower Meso-trias (Anisian)	Paraceratitan	<i>Procerastes</i> Beds (Ismid, Kashmir). <i>Ptychites</i> Beds (<i>ibid.</i>). <i>Gymnites</i> Beds (Kashmir). <i>Paraceratites antecessens</i> Beds (Lower Wellenkalk). <i>Beneckeia buchi</i> Beds (Wellen Dolomite). <i>Nicomedites</i> Beds, Ismid.
	Beyrichitan	" <i>Sibirites</i> " and <i>Durgaites</i> Beds, Himalayas. <i>Parapopanoceras</i> Beds, California.

"biogenetic law". For the present, however, we are not concerned with the derivation of *Ceratites*, *s.s.*, but with the correlation of the Germanic Upper Muschelkalk; and since this formation illustrates the principles that guide us in the correlation of the whole Trias, it may be advisable to go more fully into the question of its probable age. Thus, Philippi (1901, p. 21) further shows that *Ceratites* increases in size, but does not show an appreciable advance, either in ornament or in evolution of the suture-line. Whilst this author accepts Würtemberger's (1887, p. 28) views of the acceleration in development (tachygenesis) for ammonites in general, he considers the "stagnation" or "retardation" (cunctative palingenesis) shown in *Ceratites* to be due to long confinement of the group in enclosed seas. The consequences of this isolation compared with the free development of the supposed contemporaries of the *Ceratites*, for instance, in the Mediterranean region are graphically described; but I feel convinced that this is not the sole explanation of the differences in the ammonite faunas. It may be impossible at the first attempt finally to correlate the Middle Trias, but it may well be assumed that the ceratites of the Germanic Trias existed at a time either when no ammonitiferous deposits were laid down in the Alpine-Mediterranean "province", or else when the Trachyceratids were dominant there.

The lowest beds of the Upper Muschelkalk, with early ceratites (pre-*atavus* horizons of Table IV and locally "Trochitenkalk" and Chert Beds), are superposed upon the Middle Muschelkalk (often Anhydrite Beds) without ammonoids. The Schaumkalk-forms of the upper part of the Lower Muschelkalk include both *Ptychites dux* (Beyrich) and, among other less closely-defined groups, forms of the genus *Judicarites*, Mojsisovics (= "*Arniotites*", *aunt. non Hyatt*). There is justification for correlating this Schaumkalk-fauna with, say, the black limestones of Prezzo in Judicaria, included by Mojsisovics in the *trinodosus* zone; and thus the Upper Anisian age of the Schaumkalk (= Upper Wellenkalk = Upper Lower Muschelkalk) is established.

Philippi was of opinion that "*Ceratites*" *schmidi*, Zimmermann, of the Upper Lettenkohle (= Lower Keuper) is a degenerate *Ceratites*, *s.s.*, and closely connected with the *nodosus* group. This supports Quenstedt's view that the Kohlenkeuper represents the uppermost member of the Muschelkalk Series, and in any case the true *Ceratites* are thus confined to beds preceded

by the non-ammonitiferous Middle Muschelkalk, and succeeded by the equally indefinite 1400 ft. or more of Gypskeuper. It is clear that there is a tendency to correlate beds only by relative position; and, as a result, beds that both in the Germanic sequence and in that of the Alpine-Mediterranean province were considered to represent the upper part of the Middle Trias, may yet be of different ages. Owing to this tendency, J. Perrin Smith (1914, p. 4) considered both the Ladinian Buchenstein Beds with *Protrachyceras reitzi*, and the Japanese Ceratite Shales, with a much earlier Anisian fauna, together as equivalents of the Upper Muschelkalk. In reality the faunas are entirely different. And I hold that the difference of the faunas is far better explained by assuming a difference of age in the deposits than by the limited horizontal distribution of certain ammonites (however generally important), or by the presumed isolation of the Germanic ceratites in an inland sea. This view, of course, implies considerable gaps in all the sequences, and demands a careful examination of even slight variations in the ammonite faunas.

How widely the erroneous identification of a given ammonite may mislead is strikingly shown in a recent paper by Jaworski (1922, p. 173). This author actually stated that in his opinion the occurrence of the Anisian *Nevadites* in a hand-specimen, which also contained much later species, could not effect the determination of their age as Norian, since it only showed that in South America *Nevadites* occurred in beds considerably younger than those in which it occurred in Nevada.

3. Correlation of the Buchenstein and Wengen Beds.

It may now be considered whether the differences in the ammonite faunas of the Anisian *trinodosus* zone and the Ladinian Buchenstein Beds (zone of *Protrachyceras reitzi*) on the one hand, and of the Wengen Beds (zone of *Protrachyceras archelaus*) on the other, are so great as to justify us in placing the *Ceratite* fauna of the Upper Muschelkalk in an approximately intervening time period.

It is known that the genera *Ptychites* and *Monophyllites*, together with Arcestids, which on a previous occasion (1921, p. 348) the writer characterized as the dominant elements of the fauna of the *trinodosus* zone, range up through the Buchenstein Beds and into the Upper Ladinian Wengen Beds.

Further, while we may consider that the Arpaditids of the Buchenstein Beds show great affinity with those of the Wengen fauna above, yet *Protrachyceras* (derived from *Anolcites*, which occurs in the *trinodosus* zone), can scarcely be distinguished from comparable forms even of the *archelaus* zone. Again, the still higher fauna of the lowest Carnian, with *Trachyceras aon*, is intimately allied to that of the Upper Ladinian. There appears, therefore, to be no obvious gap in which to place the Ceratite Beds. Yet it has recently been repeatedly proved that apparently successive faunas in the Jurassic and Cretaceous may be separated by considerable time-intervals, during which different faunas existed in other areas. So, in the Trias, it is likely that many faunas are still unknown, and we cannot, therefore, admit Frech's statement that there was "uninterrupted evolution of ammonites in the whole of the Alpine Middle Trias" (1911, p. 60). The horizons that Frech himself admits between the Buchenstein Beds (with *Protrachyceras reitzi*) below and the Wengen Beds (with *P. archelaus*) above show that not only negligible passage-beds, but even a formation of considerable thickness, may have to be accommodated between those two *Protrachyceras* zones.

It is clear, then, that Haug was right in separating the typical Buchenstein from the typical Wengen fauna by his zone of "*Dinarites*" *avisianus*—a zone corresponding to at least part of the great thickness of the Marmolata Limestone—in spite of the disputed identification of *Ceratites* from San Ulderico, near Recoaro, and from Sardinia with forms of the Germanic Upper Muschelkalk (1911, pp. 882–3). Since, however, the correlation and zoning of the Marmolata Limestone and comparable deposits, like the Esino Limestone of Lombardy, or the various beds of the Southern Bakony in Hungary, are as yet only general and not detailed enough for our purpose, the table of zones of the Middle Trias here given will again be merely tentative. Whether the end of the Anisian corresponds with the extinction of "*Ceratites*" *trinodosus* in the Southern Alps, as suggested by Pia (1925, p. 61), is also doubtful; and difficulties may arise again in consequence of a too wide interpretation of the numerous species of the genus *Paraceratites*.¹

¹ Since the above was written, Pia's (1930) classification has appeared, and I would only object to his use of the term Hydasopian, created for the Upper Ceratite Limestone of the Salt Range.

(f) THE UPPER TRIAS.

1. General Considerations.

The Upper Triassic Beds, on the whole, have been more completely studied than the Middle, and especially more than the Lower Trias. But here again the tendency has been to consider each incomplete section as representative of the

TABLE V.—Subdivisions of the Upper Trias.

	Age.	Zones.	Equivalents.
Rhaetic	Eopsiloceratan	. . . . .	<i>Planorboides</i> Beds (Lahnwiesgraben).
	Rhaetitan	. . . . .	<i>Choristoceras marshi</i> Beds (Osterhorn). <i>Rhaetites</i> Beds (New Zealand ?). <i>Choristoceras haueri</i> Beds (Zlambachgraben [pars]).
Norian	Pinacoceratan	<i>Sirenites argonautæ</i> . <i>Pinacoceras metternichi</i>	Pötschenkalk. Rossmoos. Zlambach Beds (pars). Someraukogel, Sandling. Röthelstein.
	Haloritan	<i>Cyrtopleurites bicrenatus</i> <i>Sagenites giebeli</i> . <i>Heinrichites paulckeii</i> .	<i>Amarassites</i> Beds in Timor. <i>Hauerites</i> Beds in Himalayas. Leislingwand. <i>Discophyllites patens</i> Beds, Someraukogel.
	Tropitan	<i>Tropites subbullatus</i> .	Milchbrunnkogel. Raschberg.
Carnian	Carnitan	<i>Carnites floridus</i> .	<i>Gonionotites</i> Beds of Sicily. <i>Rimkinites</i> Beds, Himalayas. [Bleiberg]. [Raibl].
	Trachyceratan	<i>Trachyceras aonoides</i> . <i>Trachyceras aon</i> .	Feuerkogel. Up. St. Cassian Beds. Low. St. Cassian Beds.

whole formation, rather than of only certain, often widely separated horizons. If, however, we recognize this incompleteness, it follows that even sequences like those of Spiti and Niti, given by Noetling (in Frech, 1905, pp. 150-1), with a thickness of about 3500 ft. from the base of the zone of *Joannites cymbiformis* up to the base of the Spiti Shales, probably represent only part of the Upper Trias. On the other hand, of course, it might be held that the 250-300 ft. of shales

constituting the Himalayan "zone of *Joannites cymbiformis*" represent a condensed sequence of the Lower and Middle Carnian, especially since the *Tropites* horizon proper, which is near the top of the Carnian, occurs some 400–500 ft. up in the "zone of *Tropites cf. subbullatus*". But the writer believes that the Tropitan and Trachyceratan ages are capable of division into a number of horizons, and represent considerable periods, and in support of this view it may suffice to point to the intervening Raibl Beds of the Eastern Alps. Here the *Megalodus*-Dolomite, of a thickness of 350 ft., is preceded by five other beds, of which the middle one (Taube-Schiefer of Suess) alone may be over 900 ft. in thickness. Moreover, the whole series is probably separated from the St. Cassian Beds of the Lower Carnian by a gap of unknown magnitude, which will have to accommodate not only dolomitic limestones without cephalopods and of undetermined age, but also various melaphyres.

2. Lack of Detailed Knowledge.

How misleading can be the information at present available is shown by the placing in the Carnian of such formations as the *Dawsonites* Beds of Bear Island and British Columbia, the *Nathorstites* Beds of Spitsbergen, and others. Again, the incompleteness of our knowledge of the ammonite faunas of the Rhaetic is a serious obstacle to a satisfactory subdivision of that stage, and a thickness of over 3000 ft. of marine Rhaetic at Kawhia in New Zealand is still almost untouched (Trechmann, 1918, p. 171).

D. TERMINOLOGY.

(a) GLOSSARY.

The terminology used in the systematic descriptions is mainly that adopted by the writer in his 'Monograph of the Gault Ammonoidea' (1923, i, pp. 7–9). Some additions, however, are now made to the terms there listed, although I am in sympathy with the objections of Seitz (1929), and the reader may consult Volume III of this Catalogue (p. xix) for a diagram illustrating the various proportions. The dimensions recorded in the specific descriptions are always in the following order: diameter in mm., height of the outer whorl, thickness of the same, width of the umbilicus, the last three being in

percentages of the diameter. Where two diameters are given, the figure in brackets indicates the size at which the percentages were determined.

For convenience of reference the terms used are listed alphabetically.

acme. The period of maximum (faunal) development.

adventitious. Of elements of the suture-line, formed between the median line of the venter (or siphonal line) and the outer (ventral) side of the first lateral saddle, and resulting from the secondary subdivision of either E or L or of the external saddle between them.

alticarinata. Provided with a high, ventral keel.

ammonitic. Of a suture-line with both lobes and saddles showing indentations or frilling (= indentations bipolar).

anagenesis ; *anagenetic*. Ascending, or progressive, evolution ; of such.

anguliradiata. Of ribs (costæ or striæ) with a sharp lateral bend.

angustisellate. Of a first suture-line provided with narrow ventral saddle accompanied by lateral lobes and umbilical saddles.

angustumbilicate. Narrowly umbilicated (umbilicus being between 8% and 17% of the diameter).

apophyses. Lateral processes of the aperture.

arched. Of a ventral area evenly rounded, whether wide or narrow.

auriculoid. Ear-like markings, or "parabolar nodes", on the ribs, generally at the ventro-lateral edges, resulting from presence of former mouth borders or spines (hollow or resorbed).

auxiliary. Of elements of the suture-line below (dorsal to, or dorsad of) line of involution, but usually taken to comprise the elements beyond the second lateral saddle.

baculicone. A secondarily straightened-out shell, with apex coiled, curved, or straight.

baculitid. Like a baculicone, *i. e.* straight.

bipolar. Of a suture-line with indentations appearing simultaneously both in the lobes and in the saddles.

bituberculate. Provided with two tubercles, generally on the whorl-sides.

brephic. The first post-embryonic stage of growth (= "nepionic").

bullæ. A tubercle, elongated transversely, *i. e.* radially.

bullate. Provided with bullæ.

cadicone. A barrel-shaped shell, greatly depressed, with divergent sides, and very wide venter.

camerate. Septate, *i. e.* provided with air-chambers.

carina. A distinct keel (ventral).

carinate. Provided with a ventral keel or keels.

carinatisubsulcate. Of a periphery with keel and two faint grooves.

carinatisulcate. Of a periphery with keel and two deep grooves.

carinatitabulate. Of a periphery with keel on a flattened ventral area.

- catagenesis* ; *catagenetic*. Declining or descending evolution ; of such, "degenerate".
- ceratitic*. Of a suture-line with only the lobes subdivided, but the saddles entire (= indentation unipolar).
- clavate*. Provided with clavi.
- clavus*. A tubercle elongated longitudinally, *i. e.* spirally.
- collar*. A constriction, bordered by a ridge, generally at the aperture.
- compressed*. With whorl-height greater than thickness, *i. e.* whorl-section higher than wide.
- concave*. Of a venter with wide shallow groove, occupying the whole of the ventral area.
- concarifastigate*. Of a roof-shaped venter with concave slopes.
- concarumbilicate*. With the inner margins (umbilical slopes) of whorls concave and superposed, so as to form a basin-shaped umbilicus.
- concentrumbilicate*. With the coiling regular, and with umbilical suture forming a perfect spiral.
- constricted*. Of a shell or cast with periodic sulci, representing former mouth-borders or periodic thickenings of test.
- convergent*. Of lateral areas approximating towards venter.
- convexifastigate*. Of a roof-shaped venter, with convex slopes.
- costa*. Rib.
- costate*. Provided with distinct ribs.
- craterumbilicate*. With crater-like umbilicus.
- crenate*. Of a venter provided with tooth-like projections along siphonal line.
- crenaticarinate*. Of a ventral keel provided with crenations.
- cristate*. Crested, coarsely crenate.
- densicostate*. With ribs closely set.
- densiseptate*. With septa close together.
- densistriate*. With closely set striæ.
- depressed*. With whorl-thickness greater than height, *i. e.* whorl-section wider than high.
- divergent*. Of lateral areas diverging towards broad ventral area.
- dorsum*. The antisiphonal side of a shell, in most ammonoids the inner side, in contact with previous whorl.
- embryonic*. The earliest (protoconch) stage of growth.
- epacme*. The period of increasing development.
- ephebic*. The adult stage of growth.
- epidermids*. Minutely-branching or felt-like markings on surface of some smooth ammonites.
- evolute*. Loosely coiled, so as to disclose much of the earlier whorls in the umbilicus.
- excentrumbilicate*. With the umbilicus suddenly opening out or narrowing, *i. e.* not coiled in a perfect spiral.
- falcoid*. Sickle-shaped (bend of the ribs or striæ).
- fastigate*. Of a venter merely sharpened, roof-shaped.
- flare*. A periodic "collar" or ridge, or rib, occurring at intervals on the shell.

- flared*. Provided with "flares".
- flexiradiate*. With curved striæ or costæ.
- funiculate*. With ropy keel or periphery.
- genotype*. The type-species of the genus.
- gerontic*. The "old age" or senile stage of growth. Often wrongly used in connection with modified body-chambers or apertures.¹
- goniatitic*. With the saddles and lobes of the suture-line entire, *i. e.* not indented, but not necessarily angular.
- gradumbilicate*. With the inner margins (umbilical slopes) of whorls forming perpendicular steps.
- gyral*. With whorls not in contact, but forming a regular spiral.
- helicoid*. Of coiling, as in gastropods, *i. e.* not in one plane.
- heteromorphous*. Of irregular coiling, *i. e.* not in a regular spiral as in typical ammonites.
- holotype*. The one and only type-specimen; or the one specimen designated by the nomenclator as the type-specimen out of several mentioned in the original description.
- homœomorphous*. Having similar shape in unrelated stocks; apparent identity of heterophyletic species.
- hyponomic sinus*. An indentation or bay in the aperture on the ventral area, indicating the position of the hyponome or "funnel".
- idiotype*. A specimen identified by the nomenclator himself, but not a topotype.
- inverse*. Of auxiliary elements of the suture-line if ascending towards the umbilical suture instead of going straight across whorl-side.
- involute*. Closely coiled, so as to show little of the inner whorls.
- lævigata*. Of a shell, smooth or with only faint radial lines of growth.
- latisellate*. Of an embryonic suture-line provided with a broad ventral saddle.
- latumbilicate*. With wide umbilicus (50–60% of the diameter).
- lectotype*. A specimen selected by a subsequent author as the type from a number of syntypes.
- leptogyral*. Thin-whorled (thickness being between 8% and 17% of the diameter).
- lituid*. Of a straight, simple, internal (dorsal) lobe.
- lobe*. The portions of the septal suture directed backwards.
- megalomorph*. A species of a large size; an individual of a giant species.
- metatype*. A topotype identified by the nomenclator himself.
- micromorph*. A species of a small size—an individual of a dwarf species.
- multipapillate*. Provided with many small nodes (pimples).
- multisellate*. Of a suture-line with numerous lobes and saddles.
- multituberculate*. Provided with many tubercles.
- neanic*. The adolescent stage of growth.
- neotype*. A newly selected type, in place of lost holotype or lectotype, such specimen being from the same locality and horizon as the holotype or lectotype of the original species.

¹ Presumably the ammonite animal, like the living *Nautilus*, did not propagate until after the shell was completely formed.

nodate. Provided with blunt and low tubercles.

nodostrigate. Provided with lines of papillæ arranged longitudinally, *i. e.* spirally.

occlusal. Of shells so closely coiled that the inner whorls are entirely hidden.

oligogyral. With few whorls (the outer ones often considerably overlapping the inner).

opiocone. A shell with serpental coiling.

ornatilobate. Provided with unusually complex suture-line.

oxycone. A compressed, involute shell, with very sharp venter.

pachygyral. Thick-whorled (thickness being between 50% and 66% of the diameter).

papillate. Provided with papillæ or pimples, *i. e.* very small tubercles.

parabolæ (= parabolic nodes). Auriculoids, *q. v.*

paracme. The period of decline in development.

paratype. A specimen, other than holotype or lectotype, upon which a species has been founded.

parvicarinate. Provided with a very low keel.

paucicostate. Provided with distantly-spaced ribs.

perangustumbilicate. With very small umbilicus (1–8% of the diameter).

periphery. The outer (generally siphonal) side of the whorls.

perlatumbilicate. With very wide umbilicus (over 66% of the diameter).

perleptogyral. With very thin whorls (1–8% of the diameter).

perpachygyral. With very thick whorls (over 66% of the diameter).

perplatygyral. With very wide whorls (over 66% of the diameter).

perstenogyral. With very narrow whorls (1–8% of the diameter).

phyllloid. Of saddles with leaf-like endings.

planifastigate. With flat sides to a roof-shaped venter.

platycone. A discoidal shell with broad, flat sides, and with the venter arched or acute (*oxycone*).

platygyral. With wide whorls (50–66% of the diameter).

polygyral. With many whorls, and comparatively little overlap.

prorsiradiate. With ribs inclined forwards.

protoconch. The initial chamber of a shell; the embryonic stage.

quadrituberculate. Provided with 4 tubercles; or, more generally, with 8, 4 on each side.

rectiradiate. With ribs or striæ radial and straight.

reticulate. With striation and strigation intersecting.

rostrum. A ventral process at the aperture.

rursiradiate. With the ribs or striæ inclined backwards.

saddle. The portions of the septal suture directed forwards.

scaphitoid. With modified or loosened body-chamber, resulting in elliptical or angular, boat-like shells.

septicarinate. With the keel separated from the rest by a septum, or partition.

septituberculate. With the tubercles separated from the rest by septa at the base.

- serpental*. Loosely coiled, like a coiled snake.
- serpentine*. A shell with serpental coiling.
- serreticarinata*. Provided with a very finely toothed keel.
- sigmoidal*. Of an S-shaped bend in striae or costae.
- sparsiseptate*. With septa fairly widely apart.
- sphaerocone*. A globose shell with small umbilicus.
- spinata*. Provided with spines, *i. e.* high and conical tubercles.
- stenogyral*. With narrow whorls (height being 8–17% of the diameter).
- striate*. Provided with faintly raised lines parallel to the lines of growth.
- strigate*. Provided with longitudinal (spiral) lines or ridges.
- subammonitic*. With the saddles of the suture line imperfectly notched or frilled.
- subangustumbilicate*. With fairly narrow umbilicus (17–34% of the diameter).
- subceratitic*. With the lobes of the suture-line remaining simple while saddles are already modified, as in certain Permian stocks.
- subconcaumbilicate*. With the sides of the inner whorls just visible in the concave umbilicus.
- subcostate*. With fairly distinct lines or striae, but not actual ribs.
- subgradumbilicate*. With rounded umbilical edge, leading to flattened sides, but perpendicular steps.
- sublatumbilicate*. With rather wide umbilicus (34–50% of the diameter).
- subleptogyral*. With fairly thin whorls (thickness being 17–34% of the diameter).
- subpachygyral*. With fairly thick whorls (thickness being 34–50% of the diameter).
- subplatygyral*. With fairly wide whorls (height being 34–50% of the diameter).
- subspiracone*. An inflated, but not quite globose, shell.
- substenogyral*. With fairly narrow whorls (height being 17–34% of the diameter).
- sulcate*. Of a shell with a groove at the periphery.
- suspensive*. Of dependent umbilical (auxiliary) elements of the suture-line.
- syntype*. One of several specimens on which a species has been founded, when no one has been designated as the holotype. It is the duty of the next investigator to select one among the syntypes as a lectotype.
- tabulate*. Of a truncated or flattened periphery or venter.
- tachygenesis*. Accelerated development, or the earlier inheritance of characters.
- topotype*. A specimen from the same locality and bed as the holotype.
- trituberculate*. Provided with three tubercles, generally on the ribs.
- tuberculate*. Provided with tubercles or nodes.
- turrilitid*. Coiled in an elevated spiral, like a gastropod.

unipolar. Of a suture-line whose indentations are confined to the lobes (ceratitic).

unituberculate. Provided with one tubercle (generally on the ribs).

varices. Periodic ridges (or constrictions, caused by internal thickening of the test and often showing as grooves on casts).

venter. The siphonal side of a shell, *i. e.* the outer (peripheral) in normal ammonites.

(b) LOBE-FORMULA.

With regard to the suture-line, it is desirable that nomenclature should be based on the ontogenetic development, and not on morphological resemblance. Generally the ammonites of the Trias are so poorly preserved that even adult suture-lines are often only imperfectly visible, and for this reason, and owing to insufficient material, it has been possible only in a few instances to demonstrate the earliest suture-lines. Unfortunately Branco's masterly researches of 1879 have not been followed up by similar work on other Triassic ammonoids. It is known that in all ammonoids the formation of new elements in the suture-line starts from the umbilical suture, and proceeds both outwards (*i. e.* ventrally) and inwards (*i. e.* dorsally). The embryonal suture-line in Triassic ammonites is either latisellate or angustisellate (as in all later ammonoids). The primitive (second) suture-line has already a ventral or external lobe (E) and the formation of a lateral lobe (L), and an internal or dorsal lobe (I) quickly follows. Between E and L is the external saddle; between L and I the lateral and internal saddles, with an intervening umbilical lobe (U) present already in the second suture-line of the latisellate form figured by Branco (1879, pl. v, fig. 1) as *Trachyceras cf. klipsteinianum*, Laube. Thus we have the primitive lobe-formula—

I . U . L . E ,

and the septal surface of a form of this type shows a more or less regularly stellate arrangement of the ventral and dorsal and two pairs of lateral lobes (as in a Jurassic or Cretaceous *Lyto-ceras*). Additional lobes (named in order of their appearance U_2 , U_3 , etc.), are formed either by the elevation of a new saddle in U (as in the *Trachyceras* already cited), or by the notching and consequent division of the saddle between L and U (as in *Tropites subbullatus* figured by Branco on the same plate, fig. 11). This results in a pushing out of L towards E, and of the first formed lobes U_1 , U_2 , U_3 , alternately towards I and E, and the septal surface (as in fig. 110*b*, p. 321) may show great

complexity. The suture-line, for example, represented in fig. 2*d* (showing only E and L) if completed would have eight lobes (U_{1-8}) between L and I. It is, of course, impossible, from a mere inspection of the adult suture-line or septal surface, to determine which mode of lobe-formation is present, or even to consider the lobe marked L (rather than the next and still deeper lobe) in the suture-line figured in fig. 1*a* to represent the primitive lateral lobe. As it is obviously impracticable, except in a very few species, to study ontogenetic development, the customary distinction of a first and second lateral lobe is retained in the descriptions. Auxiliary elements, as defined in the above glossary, are those below the line of involution, but

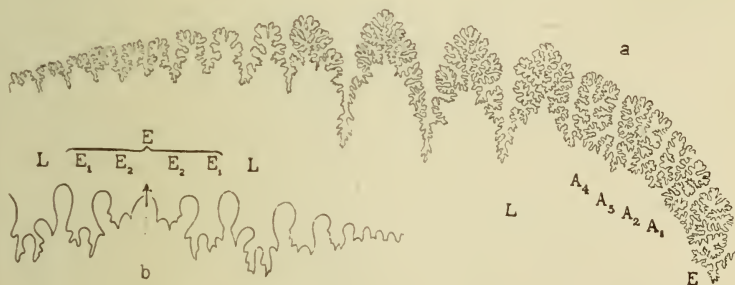


FIG. 1.—*a*. External half of suture-line of *Pinacoceras metternichi* (Hauer) var., with adventitious lobes (A_1 – A_4) resulting from subdivision of external saddle. *b*. External suture-line of *Arthaberites alexandrae*, Diener, with adventitious lobes (E_1 , E_2) resulting from subdivision of the external lobe. (After Diener, 1915*b*, pl. i, figs. 20 and 12.)

a glance at fig. 110*b* will show how the third lateral lobe may be so close to this line that it may be difficult to decide whether it should not be considered as an auxiliary lobe.

With Diener (1916, p. 592) I would consider adventitious lobes to represent merely magnified incisions. When previously (Spath, 1923, pp. 10–13) advocating a modified use of the lobe-formula of Wedekind, I explained that those adventitious lobes which were formed as a result of the subdivision of the external saddle (see fig. 1*a*) could be inserted between the external lobe (E) and the principal, or first lateral, lobe (L) as A_1 , A_2 , A_3 , etc. On the other hand, those which result from the subdivision of the first lateral lobe (L) can be formulated as L (L_1 , L_2 , L_3 , etc.). Good illustrations of this second type of

adventitious lobe are found in the Carboniferous genus *Shumardites*, Smith, and the Cretaceous genus *Coilopoceras*, Hyatt. A third case is possible, namely the appearance of adventitious lobes in the median saddle of E as in fig. 1b above. In this last case it is proposed to use the formula E (E_1 , E_2 , E_3 , etc.), but the order of E_{1-4} , as of A_{1-4} in fig. 1a, depends on the successive appearance of those lobes in ontogeny, not on a fixed method of counting from the siphonal line inwards.

The following diagram (fig. 2) of the development of the suture-line of a form said to belong to the Upper Triassic *Sageceras haidingeri*, Hauer sp. (after Branco, 1879, pl. vi,

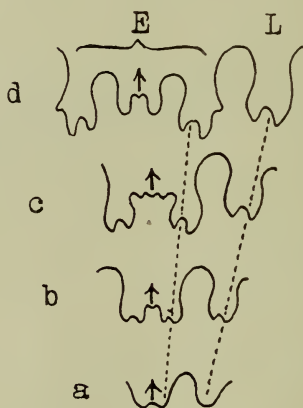


FIG. 2.—Development of adventitious elements in the external lobe of the suture-line of a Triassic ammonite (adapted from Branco, 1879, pl. vi, figs. 9h-n).

fig. 9), will show how adventitious lobes appear as a result, in this case, of the subdivision of the median saddle in E.

As already mentioned, the development of the suture-line has, up to the present, been worked out for only a few forms, in spite of the promising start made by Branco so long ago as 1879; but this is probably because authors realized the limitations of this feature, and the importance attached by Schindewolf to the order of appearance of the subdivisions of the umbilical lobe seems to me altogether unjustified. U_1 is to me simply the first one to appear, wherever it happens to lie. It cannot be recognized, on inspection, because it may or may not subdivide with increase in size, but its systematic significance is *nil*, if taken by itself.

PART II.—SYSTEMATIC

I. Super-family PRONORITIDA, Hyatt and Smith.

1905, p. 108, emend.

DIAGNOSIS. Discoidal, compressed, descendants of Prolecanitida tending to become more involute and to subdivide bases of the lobes, often in an irregular manner.

A. Family MEDLICOTTIDÆ, Karpinsky, 1889, p. 45, emend.

See *supra*, p. 14.

DIAGNOSIS. Involute platycones, with sulcate or tabulate, bicarinate, venter and a subceratitic, multisellate, suture-line with a modified external saddle.

REMARKS. The only Triassic genus of the family is *Episageceras*, Noetling. With Noetling we may conveniently group it in a restricted family Medlicottidæ, of which the only other genera are *Medlicottia*, Waagen (genolectotype: *Goniatites orbignyianus*, Verneuil, see Foord and Crick, 1897, p. 266¹), and *Eumedlicottia*, gen. nov.,² founded for forms with the saddles, as well as the lobes, notched. Karpinsky (1926, p. 8) founded the genus *Artinskia* for *Medlicottia artiensis* (M. v. Grunewaldt), which connects the Medlicottidæ, as here restricted, with the Sicanitinae, Noetling, emend. It differs from the typical Medlicottids in having the edges of the periphery crenulate.

¹ *Medlicottia primas*, Waagen, which Noetling unjustifiably selected as genotype in 1904 (p. 336), belongs to *Eumedlicottia*.

² GENOTYPE. *Medlicottia bifrons*, Gemmellaro, 1887, p. 53, pl. ix, figs. 16-19.

DIAGNOSIS. Discoidal, smooth, involute platycones with concave venters. Suture-line as in *Medlicottia*, with modified external saddle, but with saddles subdivided as well as the lobes.

REMARKS. *Eumedlicottia* is connected with the typical *Medlicottia* by forms like *M. marcoui*, Gemmellaro (1887, pl. ix, figs. 6-10), in which the subdivision of the saddles is only just indicated.

I. Genus **EPISAGECERAS**, Noetling, 1904, p. 363.

Kutassy, 1933, p. 510.

GENOTYPE. *Sageceras* (*Medlicottia*) *wynnei*, Waagen, 1887, p. 81, pl. viii, fig. 2. (Diener, 1915a, p. 131.)

DIAGNOSIS. Discoidal, involute *Medlicottidæ*, with venter broadly tabulate and bordered by two sharp keels. Suture-line with entire saddles, as in *Medlicottia*, but with a bifid siphonal lobe, as in *Eumedlicottia* and *Artinskia*.

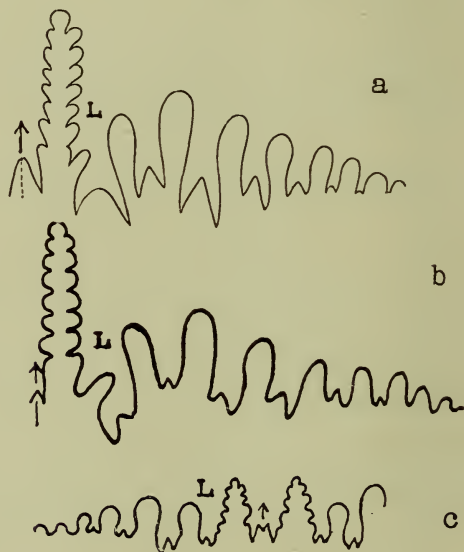


FIG. 3.—External suture-lines of *Episageceras* showing modified external saddle. (a) *E. dalailamæ* (Diener). Lowest Eo-trias. (After Diener, 1915b, pl. i, fig. 1.) (b) *E. wynnei* (Waagen). Upper Permian. (After Noetling, 1904, pl. xvii, fig. 2b.) (c) *E. latidorsatum*, Noetling. Lower Eo-trias (1904, pl. xviii, fig. 2b).

DISTRIBUTION. Permian to Upper Eo-trias. J. P. Smith (1927b, p. 23) recorded a specimen of the Timor *Episageceras noetlingi*, Haniel, associated with forms of the *Anasibirites* horizon of the Upper Eo-trias, and there is a small Timor *Episageceras* in the Collection (C. 34044 from Toeboelopo), which is also associated with Upper Eo-triassic forms. It is unfortunately too immature to be identified specifically.

1. *Episageceras latidorsatum*, Noetling.

Fig. 4.

1904, p. 372, pl. xviii, figs. 2, 2a, b (holotype); Diener, 1915a, p. 131.

DIAGNOSIS. Platygyral, subleptogyral angustumbilicate, *Episageceras*. Sides flattened, unornamented, venter tabulate. Suture-line (fig. 3c) with more pyramidal external saddles than other forms of *Episageceras*.

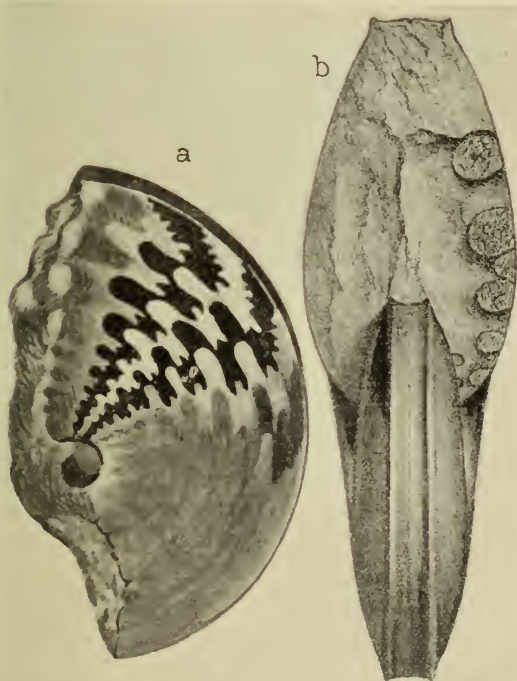


FIG. 4.—a. *Episageceras latidorsatum*, Noetling. Lower Eo-trias, Virgal, Salt Range. (After Noetling, 1904, pl. xviii, fig. 2.)
b. *E. dalailamæ* (Diener). Lowest Eo-trias. Shalshal Cliff, Himalayas. (After Diener, 1897, pl. i, fig. 6b.)

REMARKS. The lobe marked L in fig. 3c was interpreted by Noetling as an adventitious lobe, resulting from the subdivision of the external saddle, but Diener (1915b, p. 27) has shown that this view is probably erroneous. The Timor *E. kasliuense*, Haniel (1915, p. 146, pl. xi, figs. 7a-d), with a similarly bifid

median saddle in the external lobe, differs only slightly in the depth of the lobes, but the small example in the Collection (C. 34044 already referred to) is too immature to be satisfactorily compared with the present species. *E. intermedium*, Welter (1922, p. 93, pl. clv, figs. 1, 2), from the Owenitan of Timor, belongs to a different group of *Episageceras*.

HORIZON AND LOCALITIES. Lower Eo-trias, Gyronitan, zone of *Prionolobus rotundatus* = Lower Ceratite Marls of the Salt-Range, Punjab, India.

SPECIMENS :

- C. 10415.** Corroded specimen of 31 mm. diameter, with ventral area less broad than Noetling's fig. 2a on pl. xviii. Virgal, Salt Range. *Koken Coll. Purchased 1905.*

B. Family SAGECERATIDÆ, Hyatt, 1900, p. 555.

DIAGNOSIS. Involute platycones, with tabulate or finely bicarinate, sometimes acute, venters (on test only ?) in adult. Suture-lines ceratitic to subceratitic, multisellate; external saddles subdivided into numbers of adventitious elements.

REMARKS. The two principal genera of this family, namely, *Pseudosageceras* and *Sageceras*, had been united by Hyatt in a family Sageceratidæ; but Hyatt and Smith later (1905, p. 98) included them in Pinacoceratidæ. Noetling (1905a, p. 180), who accepted Diener's view as to the direct connection between *Pseudosageceras* and the Anisian *Arthaberites* (here included in Noritidæ), stated that it had to be considered whether these two genera should not be separated as an independent family. Arthaber (1911, p. 180) referred *Pseudosageceras* and *Sageceras* again to Beloceratidæ, and Diener (1915b, p. 60) put the former genus in the neighbourhood of *Hedenstræmia*, which he described as undoubtedly more easily traceable to *Meekoceras* than to any member of Arthaber's family Prodromitidæ. Hyatt and Smith also had stated that a near relative, and possible ancestor, of *Pseudosageceras* might be found in *Prodromites*, Smith and Weller, of the Lower Carboniferous, so that the genus here discussed and *Hedenstræmia* might indeed be thought to be connected. But whilst accepting, with Diener, *Hedenstræmia* as a "Meekoceratid" (really Paranoritid) development, we are constrained to deny its relationship with *Pseudosageceras*, of which typical examples already occur in the *Ophiceras* layer of Pastannah, Kashmir (see fig. 5). *Pseudosageceras* is therefore

here considered probably to represent a special offshoot of the Sicanitinæ, rather than of the Medicottidæ in the restricted sense—a slowly evolving and long-lived offshoot already specialized before the “Meekoceratids” [*s.l.*] began to become a dominant element in the ammonoid fauna. Diener (1915*b*, p. 41) has well demonstrated that *Sageceras* agrees with *Pseudosageceras* in the formation of adventitious lobes and saddles;

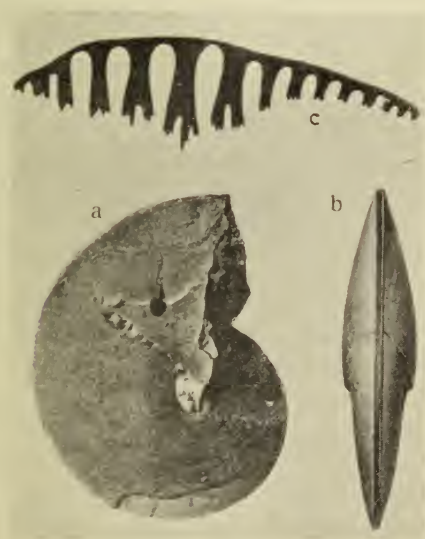


FIG. 5.—*Pseudosageceras clavisellatum*, Diener. Lower Eo-trias, “Ophiceras Layer” of Pastannah, Kashmir. (After Diener, 1913, pl. iv, figs. 5*a-c*.)

and the differences insisted on by Diener between the Sageceratidæ and the Sicanitinæ (Medicottidæ, *s.l.*) are not here considered to be of more than family importance. For with so much more material available it is no longer possible to divide the Ammonoidea into Latisellata and Angustisellata, and the high external saddle in Medicottidæ itself is, of course, a specialized feature.

Cordillerites is included in, and *Aspenitids* are excluded from, the present family for the reasons stated below (pp. 61 and 227).

Genus **PSEUDOSAGECERAS**, Diener, 1895, p. 28.

Kutassy, 1933, p. 629.

GENOTYPE. *P.* sp. indet. Diener, 1895a, p. 28, pl. i, fig. 8 (Hyatt and Smith, 1905, p. 98).

DIAGNOSIS. Sageceratidæ whose shells are involute platycones, with tabulate or finely bicarinate venters and multisellate suture-lines.

DISTRIBUTION. Lower Eo-trias, Otoceratan to Columbitan.

REMARKS. Diener (1915a, p. 236) quoted as genotype *P. multilobatum*, Noetling, a species not described till 1905. Arthaber (1911, p. 202) considered that Diener's *P.* sp. ind. of 1895 was comparable with one of Noetling's examples (No. 43) of *P. multilobatum*, and Diener may have accepted this view. But since it is possible that the fragmentary Ussuri form may yet turn out to differ specifically from the Salt Range species, it is here, after Hyatt and Smith (1905, p. 98), listed as the genotype.

Frechiceras, v. Krafft (1902, p. 5), according to Diener (in v. Krafft and Diener, 1909, p. 145), was based on two specimens of *Pseudosageceras multilobatum*.

***Pseudosageceras multilobatum*, Noetling.**

Fig. 6a, p. 56.

1905, p. 181, pl. xix, figs. 1, 1a (lectotype), 2-5; pls. xx-xxvii;
Diener, 1915a, p. 237; Diener, 1915b, p. 35, pl. i, fig. 13;
Welter, 1922, p. 94, text-fig. 3; J. P. Smith, 1932, p. 87;
Kutassy, 1933, p. 630.

DIAGNOSIS. Platygyral, leptogyral, perangustumbilicate *Pseudosageceras*. Test smooth; venter narrowly tabulate. Suture-line complex, ceratitic, with a maximum of 46 lobes and 51 saddles (*vide* Noetling), but extraordinarily variable (see fig. 6a).

REMARKS. This species differs from *P. drinense* in having a tabulate venter in the adult, a less compressed whorl-shape, and a different suture-line. *P. "intermontanum"*, Hyatt and Smith (1905, p. 99, pl. iv, figs. 1-3, etc.), has a suture-line similar to that of the present species, and although some examples have the more discoidal whorl-shape of *P. drinense*, J. P. Smith in 1932 (p. 88) united *P. intermontanum* and *P. multilobatum*.

HORIZON AND LOCALITIES. Upper part of Lower Ceratite Limestone and Ceratite Marls, Gyronitan and Flemingitan; Salt Range. Flemingitan and Owenitan; Timor, Idaho, California.

SPECIMENS :

- C. 10423, 10443, 10445. Three specimens, of which the largest, at 85 mm. diameter, is still completely septate. Lower Limestone and Ceratite Marls, Chideru. Ceratite Marls, Virgal. *Koken Coll., purchased, 1905.*
- C. 33797-807. Toeboelopo, Timor. *M. E. Walsh Coll., 1930.*
- C. 33808. Nifoekoko, Timor. *Same Coll.*
- C. 37188. Toenioen Eno, Timor. *Same Coll.*

***Pseudosageceras drinense*, Arthaber.**

Fig. 6c, p. 56.

1908, p. 279, pl. xii, figs. 3a, b (holotype, "*Pseudosageceras multilobatum*"); 1911, p. 201, pl. xvii, figs. 6, 7; Diener, 1915a, p. 236; Kutassy, 1933, p. 629.

DIAGNOSIS. Platygyral, leptogyral, perangustumbilicate *Pseudosageceras*. Test smooth; venter at first narrowly tabulate, later acute (in some examples?). Suture-line with lobes very unequally divided (fig. 6c).

REMARKS. This species was first described by Arthaber as *P. multilobatum*, but the differences between that species and *P. drinense* have already been referred to above. *P. clavissellatum*, Diener (1913, p. 28, pl. iv, figs. 5, 6), with similar whorl-shape, has club-shaped saddles and more regular lobe-bases; but Arthaber's drawing of the suture-line of *P. drinense*, here reproduced, is probably diagrammatic; for there is considerably less difference between this and the suture-line of *P. albanicum*, described below, than a comparison of Arthaber's figs. 5 and 7 might suggest.

HORIZON AND LOCALITIES. Upper Eo-trias, Albania.

SPECIMENS :

- C. 22984-98, 23002. Fifteen metatypes, including some doubtful fragments, and one specimen (C. 23002), determined by G. v. Arthaber as *Sageceras albanicum*, which did not show the suture-line until it was prepared by the writer. The shell is still well tabulate at 75 mm. diameter. Kçira, Albania.

F. Nopcsa Coll., purchased, 1922.

Pseudosageceras albanicum (Arthaber).

Fig. 6b.

1908. *Sageceras albanicum*, Arthaber, p. 281, pl. xiii, figs. 1a, b (holotype).

1911. *Sageceras albanicum*, Arthaber, p. 203, pl. xvii, figs. 4, 5.

1915. *Sageceras albanicum*, Arthaber, Diener, p. 249.

1933. *Sageceras albanicum*, Arthaber, Kutassy, p. 651.

DIAGNOSIS. Platygyral, leptogyral, perangustumbilicate *Pseudosageceras*. Venter narrowly tabulate, slightly raised in the middle, and bordered by keeled edges. Test with sigmoidal

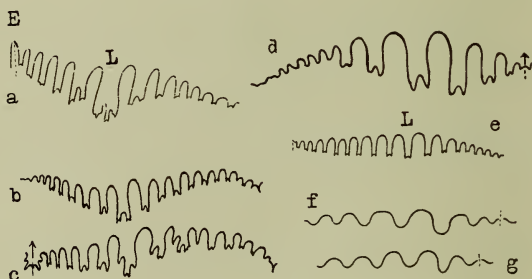


FIG. 6.—External suture-lines of *Pseudosageceras* and *Sageceras*. *a*, *Pseudosageceras multilobatum*, Noetling. Lower Eo-trias, "Hedenstræmia Beds" of Muth, Himalayas. (After v. Krafft and Diener, 1909, pl. xxi, fig. 5c.) *b*, *P. albanicum* (Arthaber). Upper Eo-trias, Albania. (After Arthaber, 1911, pl. xvii, fig. 5.) *c*, *P. drinense*, Arthaber. Same formation and locality. *Ibid*, fig. 7. *d*, *Sageceras walteri*, Mojsisovics. Middle-Trias, Anisian, Nevada, U.S.A. (After Hyatt and Smith, 1905, pl. lxxv, fig. 15.) *e-g*, *Sageceras haidingeri* (Hauer). Upper Eo-trias, Carnian, Austria. *e* = Adult. (After Mojsisovics, 1882, pl. liii, fig. 10c.) *f, g*. = Two consecutive suture-lines (enlarged) of an immature form at whorl-height of 2.5 mm. (After Diener, 1915b, pl. i, figs. 18, 17a, b.) All reduced to $\frac{2}{3}$ of originals.

lines of growth, which are occasionally bundled so as to simulate faint ribs, and are projected forwards peripherally. Suture-line (fig. 6b) with more regularly sub-bifid lobes than in other species of *Pseudosageceras*.

REMARKS. Arthaber has already emphasized the close relationship that existed between his *Pseudosageceras* and the true *Sageceras*. When it is considered that the Albanian forms are so preserved that the suture-lines can only be exposed by

grinding and the use of acid, it will be readily seen that the figures here reproduced (after Arthaber) are necessarily diagrammatic, and often composite. In *P. albanicum* the two deepest lobes, namely, E_6 and L, are distinctly unequally divided, the larger outer branch of each showing a median projection, which is not sufficiently indicated in the figure. Moreover, the second lateral lobe is little more than half the length of L and decidedly shorter than E_6 , whilst the auxiliaries are like those of *P. clavisellatum*, Diener. The suture-line thus points to *Pseudosageceras* rather than *Sageceras*, and the umbilicus, which is already closed at a very early stage, supports the reference of *P. albanicum* to *Pseudosageceras*. For in young *Sageceras walteri*, Mojsisovics, the whorl-shape agrees with that of the contemporary *Noritæ*, and in the still later *S. haidingeri* (Hauer) the umbilicus is comparatively open. It must be admitted, however, that *P. albanicum* is closer to the later genus *Sageceras* than any of the other species of *Pseudosageceras* known at present.

HORIZON AND LOCALITIES. Upper Eo-trias. Albania.

SPECIMENS :

C. 22999-23001, 23003-12. Thirteen metatypes. In some of these, however, the suture-line is not seen and they may possibly be *P. drinense*. Kçira, Albania.

F. Nopcsa Coll., purchased, 1922.

Genus **SAGECERAS**, Mojsisovics, 1873, p. 69.

Kutassy, 1933, p. 651.

GENOTYPE. *Goniatites haidingeri*, Hauer, 1847, p. 264, pl. viii, figs. 9-11.

DIAGNOSIS. Sageceratidæ having discoidal shells with small umbilicus and narrowly tabulate venter, which is bordered by keeled edges. Lines of growth sigmoidal. Suture-line ceratitic, with numerous adventitious and auxiliary elements.

DISTRIBUTION. Middle and Upper Trias, Anisian to Carnian.

REMARKS. J. P. Smith (1914, p. 49) stated that *Sageceras* was not a descendant of *Pseudosageceras*, but "rather a more primitive type". The development of the suture-line given by Branco (1879, p. 43, pl. vi, fig. 9) and Diener's remarks on the growth of the young *Sageceras haidingeri* (1915b, p. 41) may possibly be used to demonstrate an entirely different origin, and a connection, say, with *Noritidæ*; but the resemblance of

the Middle Triassic species *S. walteri* (and "*S. gabbi*", Mojsisovics) to the Lower Triassic *Pseudosageceras* is remarkably close if it is merely an instance of homœomorphy. The regular bifurcation of the lobes and the opening-out of the umbilicus may well be the result of normal development in a *Pseudosageceratid* stock.

***Sageceras walteri*, Mojsisovics.**

1882, p. 187, pl. liii, figs. 9a-c (lectotype); 1915a, Diener, p. 249; 1916, Kraus, p. 254; 1933, Kutassy, p. 652.

DIAGNOSIS. Platygyral, leptogyral, perangustumbilicate *Sageceras*. Venter narrowly tabulate, sometimes subconcave, with high marginal ridges. Umbilical wall rounded. Test striate, with radial folds, sometimes indistinct, on outer half of flat lateral area. Four or five principal lobes in suture-line, five or more adventitious, and five or more auxiliary lobes.

REMARKS. The diagnosis of this form as given by Mojsisovics is not very satisfactory, and it is not surprising that authors have often been unable to find differences between this species, as figured by Mojsisovics, and the well-known *S. haidingeri* (Hauer). Diener (1915a, p. 249) listed them as separate species, and, if we restrict *S. walteri* to the earlier (Anisian and Ladinian) forms, it is possible to adopt this separation; for, as a rule, the umbilicus is smaller, its rim rounded, and the inner whorls, resembling those of *Norites*, even to the presence of "epidermids", are more inflated and more convex laterally. These, however, are exactly the characters that, in addition to a simpler suture-line, are said to separate *S. gabbi*, Mojsisovics (fig. 6d, p. 56), from *S. haidingeri*. Together with these forms, however, there occur already in the *trinodosus* zone examples that are inseparable from the later *S. haidingeri*, except perhaps in the absence of the umbilical rim, and it must be left for future detailed work to demonstrate the correctness of the view here adopted, namely that the former represent the true *S. walteri*. The separation of this species from *S. haidingeri* merely on the basis of the slight differences in the suture-lines does not seem possible. *S. gabbi*, Mojsisovics, on the other hand, as represented by the young example figured by Hyatt and Smith (1905, pl. lxxv, figs. 14, 15, see text-fig. 6d, p. 56), may be held to have a simpler suture-line, but the only (fragmentary) example in the Collection does not show this. A young Bosnian example of *S. walteri* (C. 20355), however, shows equal simplicity, and the

writer can see no essential difference from the suture-line of even a young example of *S. haidingeri* in the Mojsisovics Collection (C. 5594). The large American example figured by J. P. Smith on plate xxi, figs. 18-20, is in any case here included in *S. walteri*.

HORIZON AND LOCALITIES. Anisian and Ladinian. Eastern Alps, Bosnia, Greece, Turkey, California, Timor.

SPECIMENS :

C. 12315-9. Five examples from the Ladinian, Wettersteinkalk, Zugspitz, Bavaria. In exchange with the Bavarian State Museum, 1909. See Reis, 1905, p. 118.

C. 5453. ("Zone of *Paraceratites trinodosus*"), Schreyer Alm, nr. Hallstatt. *E. v. Mojsisovics Coll.*, 1889.

35949. Large, septate half from St. Cassian.

Klipstein Coll., labelled "*Am. metternichi*".

C. 12404. Fragment from Lower Anisian, Beyrichitan. Gulf of Ismid, Sea of Marmara, Asia Minor.

Purchased, 1909.

C. 13948. Fragment from same beds at Tepekoi, N.W. of Diliskelessi station on the Anatolian Railway.

Purchased, 1909.

C. 20353-5, 21023-8, 21030-34, 21068, 26114-19. Twenty-one examples from the "*trinodosus* zone", Paraceratitan. Stavljan, Volujak Mts., Bosnia.

C. 21066-7. From the same beds at Suha, on the Sutjeska.

C. 21029. From the same beds at "Church of Moholjaca".

All from V. Havelka Coll., purchased 1906-8.

C. 23065. Gimaj, Albania. *Baron F. Nopcsa Coll.*, 1922.

C. 30925. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada, U.S.A. (= *Sageceras "gabbi"*, Mojsisovics). *Purchased*, 1927.

C. 33809, 33810. Toeboelopo, Timor.

M. E. Walsh Coll., 1930.

Sageceras haidingeri (Hauer).

Fig. 7.

1847, p. 264, pl. viii, figs. 9-11 (holotype); Diener, 1915a, p. 249; Kutassy, 1933, p. 651.

DIAGNOSIS. Platygyral, leptogyral, angustumbilicate *Sageceras*. Venter narrowly tabulate, medianly convex and with

marginal ridges. Umbilical edge abrupt, often bordered by spiral depression. Test striate or with indistinct sigmoidal folds, reclined on inner and again on outer lateral area. Five larger lobes in suture-line and numerous adventitious and auxiliary elements (figs. 6e-g, p. 56).

REMARKS. It has already been mentioned that the separation of *S. haidingeri* from the earlier species of *Sageceras* is often difficult, but that the more open umbilicus of the later form, surrounded often by a spiral depression, seems to be a valuable diagnostic character. But, if this character is adopted as

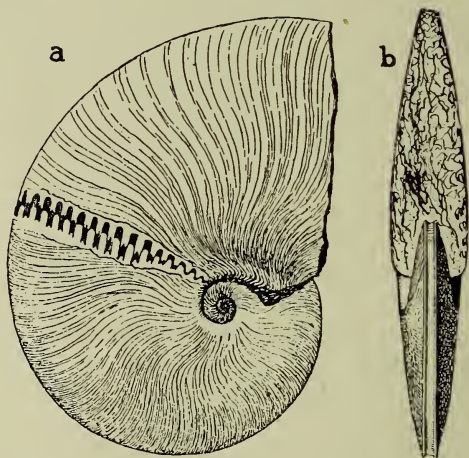


FIG. 7.—*Sageceras haidingeri* (Hauer). Upper Trias, Carnian. Röthelstein, near Aussee. (After Zittel, 1884, p. 433, fig. 602.)

diagnostic, the two large examples figured by Mojsisovics (1882, pl. liii, figs. 11 and 12 with the numbers exchanged, see 1902, p. 313) as *S. walteri* will have to be included in the species here discussed, in spite of slight differences in the number of sutural elements. Similarly, one of the four examples figured by Salomon (1895, p. 189, pl. vii, fig. 4 only) as *S. walteri*, as he correctly observes, is clearly transitional to the present species. With imperfect examples, such as that figured by Renz (1910, p. 529, pl. xviii, fig. 2), with the umbilical edge damaged or missing, it becomes a matter of personal opinion whether reference to the present species or to *S. walteri* seems appropriate.

HORIZON AND LOCALITIES. Upper Trias, Carnian. Alps, Greece, Rumania.

SPECIMENS :

39878. From Upper Trias, Lower Carnian, " zone of *Trachyceras aonoides* ", of the Salzkammergut, Austria, without exact locality. Purchased J. Rothschild, Paris, 1864.

C. 5550. From Raschberg, Goisern, Austria.

E. v. Mojsisovics Coll., 1889.

C. 5594, C. 6325a-c. From Feuerkogel, Röthelstein, nr. Aussee, Austria. *Same Coll.*

C. 13633. Same locality. Purchased B. Stürtz, 1910

Genus **CORDILLERITES**, Hyatt and Smith.

1905, p. 109 ; Diener, 1915a, p. 112 ; 1915b, p. 37, pl. i, fig. 11 ; J. P. Smith, 1932, p. 95 ; Kutassy, 1933, p. 491.

GENOTYPE. *C. angulatus*, Hyatt and Smith, 1905, p. 110, pl. ii, figs. 1-3 (see fig. 8, p. 62).

DIAGNOSIS. Compressed, involute, discoidal Sageceratidæ with tabulate venter, flattened sides and faint radial folds or striæ of growth. Suture-like slightly more irregular than in typical Sageceratids, and lobes with only few indentations.

DISTRIBUTION. Upper Eo-trias, Owenitan. Idaho, U.S.A.

REMARKS. Diener has shown that Hyatt and Smith were probably wrong in deriving this genus direct from *Pronorites*, and that in the formation of its suture-line it exhibited close affinity with *Hedenstrœmia* as well as with *Pseudosageceras*. The convergence of several Hedenstrœmids towards the family Sageceratidæ is striking, but the discovery, by Mathews (1929), of a *Pseudosageceras* (*P. "intermontanum"*, Hyatt and Smith), together with a *Cordillerites* (*C. compressus*, Mathews), showing a suture-line built on an identical plan, confirms the affinity of the genus *Cordillerites* with the Sageceratidæ. The intimate kinship of *Cordillerites* with *Medlicottia*, insisted on by J. P. Smith in 1932 (p. 95), is to me less obvious.

Genus **PARASAGECERAS**, Welter.

1915, p. 113 ; Kutassy, 1933, p. 608.

GENOTYPE. *P. discoidale*, Welter, 1915, p. 113, pl. lxxix, figs. 4a-c.

DIAGNOSIS. Involute, discoidal, Sageceratidæ with rounded periphery and flattened whorl-sides, showing inflation near

venter. Faint, sigmoidal ribs, projected and most distinct near periphery, but not continuous across it. Suture-line as in *Pseudosageceras* or *Sageceras*, with adventitious and numerous auxiliary lobes.

DISTRIBUTION. Anisian (beds with *Gymnites meridianus*), Timor.

REMARKS. The remarkably *Placites*-like shape of this rare genus may easily cause misidentification, but the suture-lines are characteristic. The development is unknown, but I am

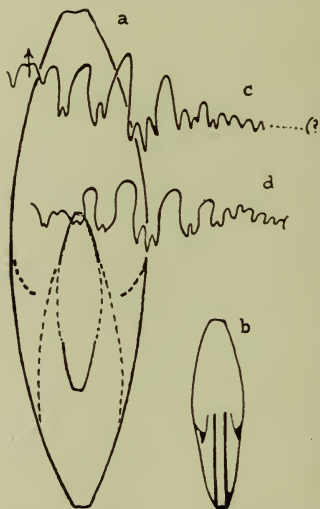


FIG. 8.—*Cordillerites angulatus*, Hyatt and Smith. Upper Eo-trias, Meekoceratan, Idaho, U.S.A. a, c, Outline whorl-section and external suture-line of a large specimen (reduced to $\frac{2}{3}$ linear). b, d, Same of an immature example. (Section reduced to $\frac{2}{3}$ linear, suture-line enlarged, $\times \frac{4}{3}$.) (Adapted from Hyatt and Smith, 1905, pl. lxxviii, figs. 2 and 3, and pl. ii, figs. 2 and 3.)

inclined to consider the deepest lobe to be the lateral lobe L, with two or more larger lobes and one small adventitious lobe between it and the siphonal line, as in *Cordillerites*.

***Parasageceras* aff. *discoidale*, Welter.**

(See Fig. 9a-c.)

1915, p. 113, pl. lxxix, figs. 4a-c.

DIAGNOSIS. Platygyral, leptogyral, perangustumbilicate *Parasageceras*, with only three adventitious lobes on siphonal side of deep fourth lobe, which is taken to be the first lateral lobe.

Measurements :

Holotype (Welter) 35·5 . 63 . 17 . 00

REMARKS. A septate fragment in the Collection with a suture-line like that of the holotype, at a whorl-height of 16 mm. has a thickness of 6·25 mm., so that it is slightly more inflated than Welter's original. Conversely, the form described below as *P. gracile*, sp. nov., at 18 mm. has a thickness of only 4·75 mm. and is far more compressed, so that there are clearly two distinct species, quite apart from the differences in suture-line.

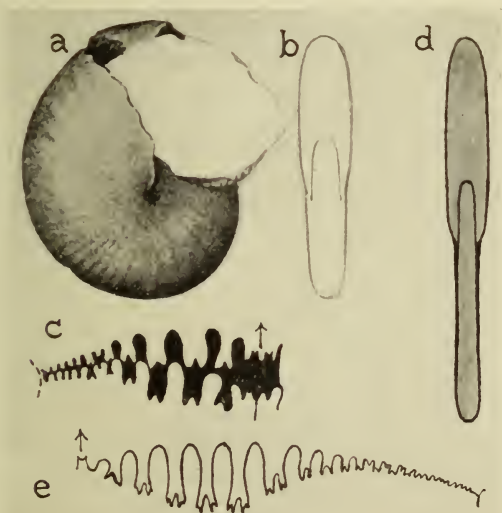


FIG. 9.—a-c, *Parasageceras discoidale*, Welter. Middle Trias, Timor. (After Welter, 1915, pl. lxxix, figs. 4a-c.) d, e, *P. gracile*, sp. nov. Sectional outline of holotype (no. C. 37207) and external suture-line of a paratype (no. C. 37192). (c and e enlarged $\times 2$.)

Unfortunately the fragmentary state of the only example available prevents definite identification with Welter's species, the outline whorl-section of which also suggests a greater whorl-thickness (about 20%) than the figures given by Welter in the text indicate.

HORIZON AND LOCALITIES. Middle Trias, Anisian, reddish-yellow *Gymnites meridianus* beds. Timor.

SPECIMENS :

C. 37208. Toeboelopo, Timor.

M. E. Walsh Coll., 1930.

Parasageceras gracile, sp. nov.Fig. 9*d*, *e*.

TYPE. The example (B.M., C. 37207) represented in Text-fig. 9*d*.

DIAGNOSIS. Platygyral, leptogyral, perangustumbilicate *Parasageceras*, with five principal lobes and many more elements than *P. discoidale*.

MEASUREMENTS :

C. 37207 (holotype) . 50 . .60 . .14 . .03

C. 37193 (paratype II). 30 . .60 . .15 . .02

REMARKS. This form differs from the genotype species *P. discoidale* in its more compressed whorl-shape, which is more slender even than that of forms like *Placites perauctus*, Mojsisovics sp. (1873, p. 53, pl. xxi, figs. 7, 8).

The most important difference, however, is in the suture-line, for that of *P. gracile* shows more affinity with the suture-lines of certain species of *Pseudosageceras* than the suture-line of *Parasageceras discoidale*. There are, apparently, about twenty-four saddles in the external suture-line and twelve more on the dorsal side. The internal lobe is deep, and has parallel sides, bordered by two slender saddles, still on the rounded dorsal area. The succeeding dorsal lobes are short, bifid, with the second slightly deeper than the first or third, fourth and fifth, and some of the succeeding saddles are deeply cleft (like certain of the auxiliaries in the external suture-line), so as to suggest an even greater number of elements. The holotype, as well as another fragmentary example of about 50 mm. diameter, and a second, smaller paratype are all septate to the end.

HORIZON AND LOCALITIES. Lower Meso-Trias, Anisian, Red Limestone with manganese films, zone of *Sturia mongolica*. Timor.

SPECIMENS :

C. 37192, 37193, 37207. Nifoekoko. *M. E. Walsch Coll.*, 1930.

II. Super-family XENODISCIDA, Frech, 1902, p. 634*a*, emend.

See *supra*, p. 17.

DIAGNOSIS. Evolute or involute descendants of Prolecanitidæ (through Paralecanitidæ and Xenodiscidæ, s.s.), with suture-lines increasingly more ceratitic.

A. Family OTOCERATIDÆ, Hyatt, 1900, emend.

In Zittel's Text-book of Palæontology, 1st Engl. ed., vol. i, p. 553 ; Spath, 1930, p. 7.

DIAGNOSIS. "Involute forms, with deep umbilici and generally prominent ridged umbilical shoulders; edges produced into 'ears'; venter mostly keeled tricarinate and in young or, later, acute. Ventral lobes in later forms divided by large siphonal saddles. Young under 2 mm. diameter have volutions with broad keelless venter and trapezoidal section. Anti-siphonal lobe, so far as known, entire on the sides and bifid at the ends" (after Hyatt).

REMARKS. In addition to the two genera (*Otoceras* and *Anotoceras*) listed by Hyatt, and *Metotoceras*, Spath, mentioned below, this family also includes the Upper Permian genera *Prototoceras*, Spath (genotype: *Otoceras trochoides*, Abich, in Frech and Arthaber, 1900, p. 241, pl. xix, figs. 1a, b), with simpler suture-line than the later typical *Otoceras*; and *Discotoceras*, Spath (genotype: "*Hungarites*" *raddei*, Arthaber, in Frech and Arthaber, 1900, p. 234, pl. xviii, figs. 6a, b), with small umbilicus and rim only in the young. The Permian members of this family are not represented in the Collection.

Since Bonnet (1912, p. 1742) himself recorded *Prototoceras* and *Discotoceras* from below his main "*Otoceras* Bed" (in which "*Goniatites*" *abichianus* still persisted), his later correlation of the Armenian with the Himalayan *Otoceras* fauna is not sufficiently convincing, especially in the absence of figures (1919, p. 288). It is, however, important to note that *Pseudogastrioceras* (of the family Gastrioceratidæ), the last goniatite, is neither related to Otoceratids, nor is it the ancestor of the Paranannitids, which are the only Eo-triassic stock that could be taken to connect the later Triassic involute stocks with the corresponding developments in the Palæozoic.

Only two species of *Otoceras* are here listed from the Himalayas, but the Museum hopes to obtain duplicates of the extremely rich East Greenland material collected by the Danish expeditions under Dr. Lauge Koch and partly described elsewhere, partly as yet under review. Of the abundant additional specimens, now before me, some show the complete suture-line which agrees with that of Diener's *O. draupadi* (1897, pl. iv, fig. 3b), rather than his *O. fissisellatum*.

Genus **OTOCERAS**, Griesbach, 1880, p. 105.

GENOTYPE. *O. woodwardi*, Griesbach, 1880, p. 106, pl. i, fig. 4.
(Diener, 1915a, p. 213.)

DIAGNOSIS. "Shell involute, with very deep umbilicus and rapidly increasing outer whorls. The parts of the shell on each side nearest the umbilicus bulged out into an ear-like shape, giving the section of the shell a more or less rhomboidal aspect" (Griesbach, in description of genotype).

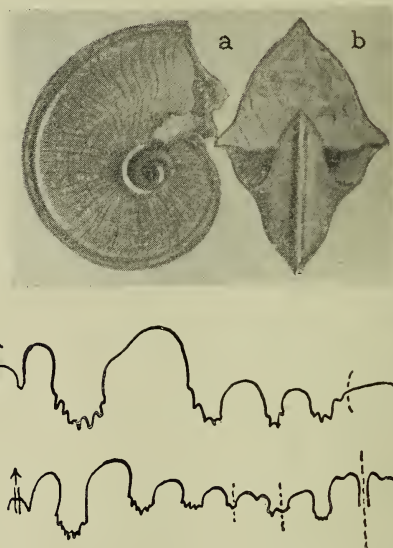


FIG. 10.—a, b, *Otoceras woodwardi*, Griesbach. Lowest Eo-trias. Himalayas. Reduced to $\frac{1}{3}$ linear. (After Diener, 1897, pl. iii, figs. 1a, b.) c, External suture-line (*ibid.*, pl. ii, fig. 1c, reduced to $\frac{5}{7}$ linear). d, Complete suture-line (*ibid.*, pl. vii, fig. 16).

DISTRIBUTION. Lowest Eo-trias, Otoceratan. Himalayas, East Greenland.

REMARKS. In a recent discussion of this genus (Spath, 1930, p. 9), I stated that Hyatt was probably wrong in assuming the ancestor of *Otoceras* to have been an *Anotoceras*-like form with a rounded venter, on which the median keel appeared gradually. The young of *Otoceras woodwardi* and its allies are compressed, discoidal, and have the three keels already well developed at a very small diameter; and *Discotoceras* and *Metotoceras* are probably closer than the more specialized *Prototoceras* and

Otoceras, or the "degenerate" *Anotoceras* to the persisting discoidal root-stock. It is therefore probable that the Otoceratidæ are more correctly placed with the Medlicottids and Sageceratids as descendants of the Prolecanitidæ, than with a globose "Nannitid" stock. Frech, in including *Otoceras* in the family Xenodiscinæ, and J. Perrin Smith, in deriving it from "*Lecanites*", also dissociated the forms here discussed from the involute Glyphioceratid offshoots.

The *Otoceras* sp. recorded by Welter (1922, p. 149) from Timor is probably a somewhat homœomorphous offshoot of the family Columbbitidæ. The identification of the Madagascan forms recorded by Douvillé (1911, p. 664), which, as Arthaber (1911, p. 272) has insisted, would not, if rightly interpreted, occur in the same bed with *Tirolites*, seems to require confirmation.

Sub-genus **OTOCERAS**, s.s.

DIAGNOSIS. *Otoceras* with the umbilical rim flared, or at least sharp.

Otoceras woodwardi, Griesbach.

Fig. 10, p. 66.

1880, p. 106, pl. i, fig. 4 (lectotype), pl. ii, figs. 2, 3, 6; Diener, 1915a, p. 213; 1925, p. 34, pl. xxii, fig. 1; Kieslinger, 1925, p. 110, text-fig. 5; Spath, 1930, p. 9; Kutassy, 1933, p. 605.

DIAGNOSIS. Platygyral, subpachygyral, angustumbilicate *Otoceras*. Venter distinctly tricarinate in young, tending to become oxynote. With a sharp, greatly projecting umbilical rim except in very young. Sides and umbilical slope smooth in adult, but with faint folds on the flat sides of immature specimens. Suture-line ceratitic, variable, with small external saddle and several auxiliary lobes (figs. 10c, d, p. 66).

MEASUREMENTS :

Diener (1897, p. 156,						
pl. ii, fig. 1) .	. 152	. .56	. .50	. .12		
Diener (1897, p. 156,						
pl. v, fig. 5) .	. 52	. .56	. .35	. .12		

REMARKS. This well-known species has been exhaustively described and figured by Diener. The examples in the Collection were all extracted from a block which also contained *Ophiceras sakuntala*, and are all incomplete or immature, so

that it is possible that some of them belong to other species described by Diener, of which, however, some are based on differences that seem scarcely of specific value. The two forms described below differ chiefly in having more sharply-defined lateral keels. *O. woodwardi* mut. *epigonus*, Frech (in Noetling, 1905, p. 131) seems to have been separated from the typical form only on account of its later age, and may include the examples here listed from a corresponding horizon.

HORIZON AND LOCALITIES. Lower Eo-trias, Otoceratan. Himalayas.

SPECIMENS :

- C. 28508-11, 12-14** (including a median section on slide).
Shalshal Cliff, Rimkin Paia. (*Ex* Griesbach Coll.)
Presented Geol. Surv. India, 1926.

Otoceras fissisellatum, Diener.

1897, p. 163, pl. iii, figs. 3*a-c* (lectotype), pl. v, figs. 2 *a, b* ; Spath, 1930, p. 10.

DIAGNOSIS. *Otoceras* resembling the last species, but the umbilicus remains funnel-shaped, the lateral keels remain prominent, the suture-line has only one auxiliary lobe, and there is an indentation in the second lateral saddle.

MEASUREMENTS :

Diener (1897, p. 163),

pl. iii, fig. 3 . 51 . .53 . .57 . .16

C. 28503 . . 28 . .59 . .48 . .10 ?

REMARKS. This form is easily recognizable by its subdivided second lateral saddle. In the small example in the Collection the radial folds are uncommonly well developed, and before the umbilical rim begins to be raised, the widely tricarinate venter and bulging sides cause this specimen almost to resemble similarly immature examples of *Frechiella subcarinata* (Young and Bird). In the equally ornamented *O. undatum*, Griesbach, the suture-line is that of *O. woodwardi*, and the whorls remain compressed to a larger diameter.

HORIZON AND LOCALITIES. Lower Eo-trias, Otoceratan. Himalayas.

SPECIMENS :

- C. 28503.** Mouth of Yet Nar Stream, between Aru and Mundlau, near Pahlgam, Kashmir.

Presented Geol. Surv. India, 1926.

Otoceras undatum, Griesbach.

1880, p. 107, pl. i, fig. 5 (*O. woodwardi*, var. *undata*, holotype).

DIAGNOSIS. *Otoceras* resembling *O. woodwardi*, but with indistinct folds following the course of the growth-striæ.

MEASUREMENTS :

Diener (1897, p. 162) 42 . .55 . .40 . .17

REMARKS. In general shape, involution and suture-line, Griesbach's holotype is scarcely distinguishable from Diener's figure (1897, pl. iii, figs. 2a-c) of an *O. clivei* of the same size, but the "wavy folds" are much more marked in *O. undatum*. The two examples in the Collection are more compressed than

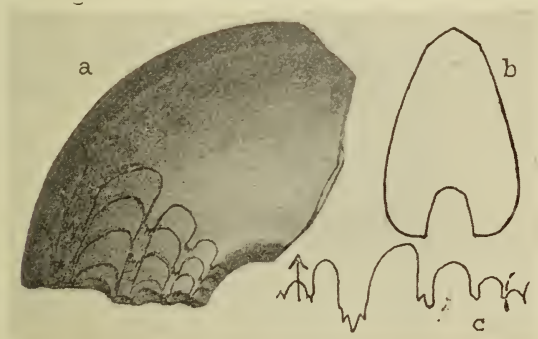


FIG. 11.—*Metotoceras dieneri*, Spath. Lowest Eo-trias, Himalayas.
(After Diener, 1897, pl. xxiii, figs. 5a-c = *Hungarites* sp. ind.).

the specimen of *O. fissisellatum*, above referred to, which has similar but more distant folds.

HORIZON AND LOCALITIES. Lower Eo-trias, Otoceratan. Himalayas.

SPECIMENS :

C. 28504-5. Yet Nar, Pahlgam, Aru Basin, Kashmir.

Presented Geol. Surv. India, 1926.

Sub-genus **METOTOCERAS**, Spath.

1930, p. 8.

GENOTYPE. *Metotoceras dieneri* Spath = *Hungarites* sp. ind., in Diener, 1897, p. 150, pl. xxiii, figs. 5a-c; 1915, p. 154.

DIAGNOSIS. Involute, discoidal *Otoceras*, with the suture-line and periphery of the typical forms, but with no umbilical rim.

DISTRIBUTION. Lower Eo-trias, Otoceratan. Himalayas.

REMARKS. The generic separation of *M. dieneri* (as *Hungarites*) from *Otoceras* by Diener already in 1897 indicates its peculiar position, but there is undoubtedly much greater affinity with the Otoceratids than with the later acute-ventered Ceratitid developments that are included in the family Hungaritidæ.

Genus ANOTOCERAS, Hyatt.

1900, p. 553 ; Spath, 1930, p. 7.

GENOTYPE. *Prosphingites nala*, Diener, *partim*, 1897, p. 54, pl. i, fig. 4, non pl. vii, fig. 13.

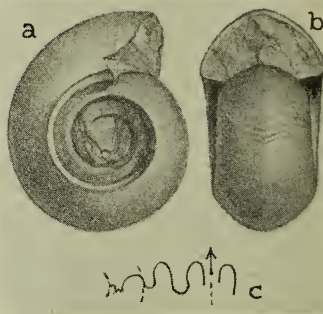


FIG. 12.—*a*, *b*, *Anotoceras nala* (Diener). Lowest Eo-trias. Himalayas. *c*, *A. kama* (Diener). External suture-line. (After Diener, 1897, pl. i, figs. 4*a*, *b* and 5*c*.)

DIAGNOSIS. Hyatt did not define this genus, and Diener (1915, pp. 36 and 233) listed it as a sub-genus of *Prosphingites*. It may, however, be retained in the present family for reduced Otoceratids with open umbilicus and rounded venter, as in the genotype, or bluntly fastigate venter as in *A. kama*, Diener (1897, p. 56, pl. i, fig. 5).

DISTRIBUTION. Lower Eo-trias, Otoceratan. Himalayas.

REMARKS. Another species of this genus is *Anotoceras intermedium*, Spath = *Prosphingites nala*, Diener, *partim*, 1897, pl. vii, fig. 13, non pl. i, fig. 4, with wider whorl-section and different umbilicus. In the later, true *Prosphingites* and allied Paranannitidæ, discussed below, the prominent external saddle is characteristic, and the sharp umbilical rim of *Anotoceras* alone

shows that the resemblance to *Prosphingites* is not so close as Diener (in v. Krafft and Diener, 1909, p. 160) had thought.

B. Family OPHICERATIDÆ, Arthaber, 1911, emend.

See *supra* p. 19 ; Spath, 1930, p. 12.

DIAGNOSIS. Primitive ophiocones, like Paralecanitidæ, with compressed elliptical whorl-section and generally rounded venters. Ornamentation generally feeble, suture-lines simple, ceratitic.

REMARKS. Of the genera included in this family, *Ophiceras* (with *Acanthophiceras*, not then separated) and *Vishnuites*, were referred by Hyatt (1900, p. 556) to the family Prionitidæ, but this is restricted below to the genus *Prionites*, Waagen, and its closer allies of later date. *Glyptophiceras*, Spath, including what the writer had previously (1921, p. 305) referred to as "the second wave of '*Xenodiscus*'", comprises ribbed *Ophiceras*, and is believed to be merely a heterochronous homœomorph of the true *Xenodiscus* and of the later *Xenodiscoides*, Spath, discussed below. Whether *Protophiceras*, Hyatt, belongs to the present family is doubtful.

Lytophiceras, Spath (instituted for the discoidal forms of the group of "*Ophiceras*" *chamunda*, Diener), is separated from the typical serpenticone shells, partly on account of the discovery of a number of new species in East Greenland, partly because *Lytophiceras* is connected with *Prionolobus* on the one hand, and *Koninckites* on the other, by forms like "*Meekoceras*" *hodgsoni* and *M. kyokticum*, Diener. It is thus the radical of the family Paranoritidæ.

The Ophiceratidæ were probably derived from that Prolecanitid stock which also gave rise to the Otoceratidæ, in addition to the Upper Permian families Paralecanitidæ, Spath, and Xenodiscidæ, s.s. The latter is restricted to what Kittl (1903, p. 28) included in "*Proceratites*", namely the two genera *Xenodiscus*, Waagen, 1879 (genotype :—*X. plicatus*, Waagen), and *Xenaspis*, Waagen, 1895 (genotype :—*X. carbonaria*, Waagen sp.). *Paralecanites* is not the direct ancestor of the Eo-triassic *Gyronites* of the group of *G. psilogyrus* (Waagen), as Diener believed, nor can Frech's reference of these forms to *Ophiceras* (1905, text to pl. xxii) be admitted, *Gyronites* being already closer to *Flemingites* than to the early Ophiceratids.

The two rare genera *Vishnuites* and *Subinyoites* are not represented in the Collection, but since describing the *Vishnuites*

in Mr. J. M. Wordie's collection (now in the Sedgwick Museum, Cambridge), I have received very large new collections from East Greenland, through the kindness of Dr. Lauge Koch, and the previous account of the Ophiceratids (with *Vishnuites*) from that country will be considerably amplified in a separate paper.

In a recent review (1931, p. 629), Arthaber objected to my ignoring the elliptical shape of some *Lytophiceras*, and to my altering the contents of the family Ophiceratidæ, Arthaber. Since he clearly does not know the true *Ophiceras*, judging by his Albanian forms, and since by his reference to the "contemporaneous" *Gyronites* he shows that he has missed the significance of dissimilar faunas, I am using the present family exactly as previously defined.

Genus **OPHICERAS**, Griesbach, 1880, p. 109.

GENOTYPE. *O. tibeticum*, Griesbach, 1880, p. 109, pl. iii, fig. 4 (genotype); Diener, 1897, p. 105, pl. viii, fig. 1; Diener, 1915a, p. 211.

DIAGNOSIS. Compressed, evolute Ophiceratidæ with rounded venter, elliptical whorl-section, and generally high umbilical wall. Smooth, and with sigmoidal striæ of growth, which sometimes coalesce to form ribs; suture-lines simple and ceratitic.

DISTRIBUTION. Lower Eo-Trias, Upper Otoceratan to Lower Gyronitan?

REMARKS. The generic name *Ophiceras* had been first used by Suess (1865) for the fimbriati, but it was afterwards thought to clash with *Ophioceras*, Barrande, and was replaced by *Lytoceras* (Anzeiger, p. 112). There seems to be universal agreement that Griesbach's name *Ophiceras* should be retained for the present group, although it might be held that *Ophiceras*, if used at all, ought to replace *Lytoceras*, Suess. Since the latter genus is now firmly established, a change of names would in any case be inexpedient, and we retain *Ophiceras* in Griesbach's sense, and may thus also suggest the family-name Ophiceratidæ.¹

¹ The case has been under consideration of the International Committee on Zoological Nomenclature, with a view to standardizing the common use of the names *Ophiceras* and *Lytoceras*; and since I publicly announced having taken this step in 1929 and 1930, the creation by Miller of the genus *Griesbachoceras* (1932) is invalid.

Sub-genus **OPHICERAS**, s.s.

DIAGNOSIS. Serpenticone *Ophiceras* with high umbilical wall and without tendency either to involution or to tuberculation.

Ophiceras tibeticum, Griesbach.

Fig. 13*d, e*, p. 75.

1880, p. 109, pl. iii, fig. 4 (lectotype); Diener, 1897, p. 105, pl. viii, fig. 1; 1915*a*, p. 212.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Ophiceras*. Whorl-section convergent, with arched venter and high and steep umbilical wall. Smooth, or with blunt sigmoidal folds. Suture-line ceratitic (figs. 13*d, e*), with simple, bifid dorsal lobe.

MEASUREMENTS:

Holotype	68	·30	·22	·43
Diener (1895, p. 105, pl. viii, fig. 5)	71	·34	·29	·45

REMARKS. This species was fully redescribed by Diener (1897, p. 105), who considered it closely allied to *O. gibbosum*, Griesbach. In 1916, however, he created the genus *Acanthophiceras* for *O. gibbosum*, on account of the conspicuous sculpture of that species. *Glyptophiceras* is now also separated from the typical forms, with which it is connected by the group of *C. ptychodes* (Diener); and the discoidal forms of the *chamunda-sakuntala* type (*Lyttophiceras*) are very closely allied to the evolute true *Ophiceras* of the *tibeticum* group, while *O. demissum* (Oppel) described below is an intermediate species. The isolated *O. dharma*, Diener (1897, p. 125, pl. xv, fig. 9), with a distinctly tabular venter, and therefore transitional to the later Gyronitids, is rather distinct; but the more typical *O. platyspira*, Diener, with only slightly flattened venter, is connected by passage-forms with the species here discussed.

HORIZON AND LOCALITIES. Lower Eo-trias, Otoceratan. Himalayas.

SPECIMENS:

C. 28533. Ath Nar, Pahlgam, Kashmir.

Presented Geol. Surv. India, 1926.

Ophiceras serpentinum, Diener.

1897, p. 110, pl. xiii, figs. 2a, b (lectotype), figs. 1, 3-7; 1915a, p. 212.

DIAGNOSIS. *Ophiceras* resembling *O. tibeticum*, "but with elliptical coiling".

MEASUREMENTS:

Lectotype	.	.	.	.	86	.33	.27	.47
Diener (1897, pl. xiii, fig. 5)	.	.	.	.	67	.33	.22	.45

REMARKS. This species is connected with *O. tibeticum* by numerous transitions, and at a comparatively small size the two forms are probably indistinguishable. Later the whorl-section of *O. serpentinum* tends to round off ventrally, as well as near the umbilicus. *O. demissum* (Oppel) is more compressed, and leads to evolute and discoidal forms.

HORIZON AND LOCALITIES. Lower Eo-trias, Otoceratan. Himalayas.

SPECIMENS:

C. 28532. About 3 miles north of Pahlgam, in the tributary of Ath Nar, Kashmir. Presented Geol. Surv. India, 1926.

Ophiceras demissum (Oppel).

1865, p. 290, pl. lxxxvi, figs. 1a-c (holotype); Diener, 1915a, p. 211; Spath, 1930, p. 14.

DIAGNOSIS. *Ophiceras* resembling *O. (L.) sakuntala*, but more evolute, with looser coiling, and with a more oval cross-section.

MEASUREMENTS:

Oppel's holotype	.	21	.	.29	.	.20	.	.45
Diener (1897, pl. xiv, fig. 6)	.	.	.	20	.	.30	.	.24
C. 28516	.	.	.	15	.	.30	.	.24
								.45
								.47

REMARKS. Diener stated that there were transitional forms between this species, as interpreted by himself, and *O. (Lytophiceras) sakuntala*; but the typical forms of *O. demissum* may easily be distinguished by peculiarities in involution, cross-section, and the sculpture of the inner portion of the whorls. The small examples here referred to the present species, which were removed from a slab also containing *O. (L.) sakuntala* and *Otoceras*, closely resemble the specimens figured by Diener in pl. xiv, figs. 5-7; but they are entirely different from the small example of the involute *O. (L.) sakuntala* figured in Diener's pl. x, fig. 7.

HORIZON AND LOCALITIES. Lower Eo-trias, Otoceratan. Himalayas.

SPECIMENS :

C. 28516, 17-24. Shalshal Cliff, Rimkin Paiar, Himalayas (ex Griesbach Coll).

Presented Geol. Surv. India, 1926.

Sub-genus **LYTOPHICERAS**, Spath.

1930, p. 19.

GENOTYPE. *Ophiceras chamunda*, Diener, 1897, p. 123, pl. xii, figs. 3a, b (as represented by B.M., C. 28529).

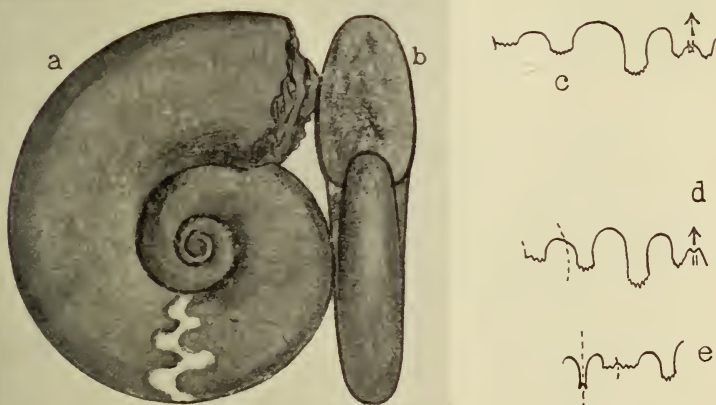


FIG. 13.—a-c, *Ophiceras* (*Lytophicerus*) *sakuntala*, Diener. Lowest Eo-trias. Himalayas. (After Diener, 1897, pl. x, figs. 4a, b and 1c; the sectional view should show greater compression peripherally (reduced to $\frac{5}{8}$ linear.) d, e, *O. tibeticum*, Griesbach (after Diener, 1897, pl. viii, figs. 1c and 3b).

DIAGNOSIS. Ophiceratidæ, which are compressed, more or less involute, discoidal developments of *Ophiceras*, without its high umbilical rim.

DISTRIBUTION. Lower Eo-trias, Upper Otoceratan (to Lower Gyronitan). Himalayas, East Greenland (Ussuri ?).

REMARKS. *Ophiceras demissum* (Oppel), described above, is somewhat transitional between the two genera *Ophiceras* and *Lytophicerus*, but also shows resemblance to some *Glyptophiceras*; even *L. sakuntala*, on account of its distinct umbilical

rim, might still be included in *Ophiceras*. On the other hand, there are now a number of new and rather distinct species from East Greenland, which make it desirable to give the discoidal offshoots a separate sub-generic name. Waagen's *Gyronites vermiformis* (1895, p. 305, pl. xxxix, figs. 1a-d) and "*Lecanites*" *planorbis* (*ibid.*, p. 278, pl. xxxix, figs. 3a-c, which may be only a worn example of the former species) might be thought to belong to the present genus, but I know these species only from the illustrations. Since they are of much later age, however, I suggested (1930, p. 19) that they should be referred (with *Prionolobus*) to the family Gyronitidae, and they might even be degenerate Flemingitids.

***Ophiceras* (*Lytophiceras*) *sakuntala*, Diener.**

Plate I, fig. 2; text-figs. 13a-c.

1897, p. 114, pl. x, figs. 1a-c (lectotype), 2-8; pl. xi, figs. 1, 2, 4;
1915a, p. 212; Spath, 1930, p. 19.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustum-bilicate *Lytophiceras*. Whorl-section compressed, elliptical, with the greatest width near the high, but rounded, umbilical edge. Venter arched, sides smooth, with faint lines of growth and spiral striation. Suture-line ceratitic, variable (see fig. 13c).

MEASUREMENTS:

Diener (1897, pl. x, fig. 2) . . .	44	·45	·23	·30
„ („ „ „ 1) . . .	69	·44	·22	·30

REMARKS. This species is connected by transitions with the more flattened *O. (L.) chamunda*, Diener, on the one hand, and the more loosely coiled true *Ophiceras* on the other. Frech (1902, p. 634f, fig. 1) established a var. *evoluta*, which, except in its tabulate periphery, resembles some *Lytophiceras* from East Greenland. The Kashmir examples recorded by Diener (1913 p. 15, pl. i, figs. 1, 2) all seem to be transitional to *L. ptychodes* (Diener). The same author's Siberian *Ophiceras* cf. *sakuntala* (1895a, p. 45, pl. ii, figs. 5, 7) are too incompletely preserved to be definitely identified with the Himalayan form, but similar *Lytophiceras* are again known from East Greenland. The "*Ophiceras*" described by Hyatt and Smith (1905, p. 119), from the *Columbites* Beds of Idaho, will be referred to below under *Submeekoceras*, with the transitional *Flemingites* ? *russelli*, Hyatt and Smith. The Albanian "*Ophiceras sakuntala*", recorded by Arthaber (1911, p. 239, pl. xxi, fig. 4) and questioned

by Diener (1913, p. 122), is probably a form of the same group, and similarly associated with *Columbites*.

The small example figured in pl. i, fig. 2, which was broken out of a block with *O. sakuntala*, differs from the normal specimens in developing two or three coarse pleats near the end. In this respect it resembles the more evolute *Ophiceras stricturatum*, Frech (in Noetling, 1905, p. 131, fig. 5), but the terminal portion, comprising about three-quarters of a whorl from the last septum, is unfortunately incomplete.

HORIZON AND LOCALITIES. Lower Eo-trias, Otoceratan. Himalayas.

SPECIMENS :

C. 28506-7, C. 28515 (?), C. 28525-7. Shalshal Cliff, Rimkin Pair, Himalayas (*ex* Griesbach Coll.).

Presented Geol. Surv. India, 1926.

***Ophiceras* (*Lytophiceras*) *chamunda*, Diener.**

1897, p. 123, pl. xii, figs. 3*a*, *b* (lectotype), 1, 2, 4; Spath, 1930, p. 20.

DIAGNOSIS. *Lytophiceras* resembling *O. (L.) sakuntala*, but elliptical, with tendency to more discoidal shape.

MEASUREMENTS :

Lectotype (figure)	.	.	.	39	·44	·22	·30
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REMARKS. Diener, who examined abundant material, considered that the elliptical shape of this "species" was original and not due to subsequent distortion in the rocks; but this character is not here considered of specific value. The more discoidal shape, the flatter whorl-sides and the absence of the distinct umbilical wall of *O. sakuntala* serve to distinguish the two forms. The resemblance of *O. chamunda* to Mojsisovics' "*Xenodiscus*" *karpinskii* (1886, p. 75, pl. xi, figs. 13*a*, *b*) seemed remarkable to Diener, but no one will now hold that the possession, by both, of an elliptical outline is "in favour of generic relationship". The Siberian species probably belongs to that group of forms transitional between the Arctoceratidæ and the Meekoceratidæ (= group of *Xenodiscus schmidtii*, Mojsisovics), which is discussed below with the Spitsbergen *Svalbardiceras*, Frebold.

HORIZON AND LOCALITIES. Lower Eo-trias, Otoceratan. Himalayas.

SPECIMENS :

C. 28529-30. South-west of Gailhand, Spiti.

*Presented Geol. Surv. India, 1926.***Ophiceras (Lytophiceras) ptychodes** (Diener).

Plate I, figs. 1a, b.

1897, p. 120, pl. xi, figs. 5a-c (lectotype), 3, 6; 1913, p. 16, pl. i, fig. 6;
1915a, p. 212; Spath, 1930, p. 21.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustum-bilicate to sublatumbilicate *Lytophiceras*. With the general shape and suture-line of *O. (L.) sakuntala*, Diener (figs. 13a-c), but with strong, sigmoidal folds on the septate portion and posterior part of body-chamber, which decline to striæ near the aperture.

MEASUREMENTS :

Lectotype (Diener, 1897, pl. xi,					
fig. 5)	.	.	.	.	.
Paratype (<i>ibid.</i> , fig. 6)	.	.	.	.	.
C. 28531	.	.	.	.	.
	56	·36	·20	·32	
	61	·36	·20	·38	
	74	·35	·22	·40	

REMARKS. The Pastannah example in the Collection seems somewhat transitional from *Ophiceras* to *Glyptophiceras* (group of *G. æquicostatum*). Not having been able to examine the Shalshal originals, I am unable to say whether they are as obviously different from *O. (L.) sakuntala* as is the Pastannah example here figured; but Diener stated that many palæontologists would probably consider *L. ptychodes* to be only a variety of *L. sakuntala*. Yet the peripheral aspect, resembling both that of a typical *Glyptophiceras* and of a *Xenodiscoides*, is different from that of *Ophiceras s.s.* and *Lytophiceras*.

The forms described below under *Glyptophiceras* differ in their costate inner whorls.

HORIZON AND LOCALITIES. Lower Eo-trias, *Ophiceras* Beds. Himalayas.

SPECIMENS :

C. 28531. Pastannah, Kashmir.

*Presented Geol. Surv. India, 1926.*Sub-genus **ACANTHOPHICERAS**, Diener, 1916, p. 101.

Spath, 1930, p. 28.

GENOTYPE. *Trachyceras* (?) *gibbosum*, Griesbach, 1880, p. 111, pl. iii, fig. 10.

DIAGNOSIS. Compressed, round-ventered *Ophiceras* with suture-line like the genotype, but with a tendency to blunt, lateral tuberculation.

DISTRIBUTION. Lower Eo-trias, Upper Otoceratan (and Lower Gyronitan ?). Himalayas, East Greenland.

REMARKS. There is a resemblance, especially of the outer whorls, to certain forms usually referred to "*Xenodiscus*", but the compressed and smooth *Ophiceras*-like inner whorls show that there is no direct genetic connection with such genera as the later *Xenodiscoides*. Some forms from the *Ophiceras*-layer

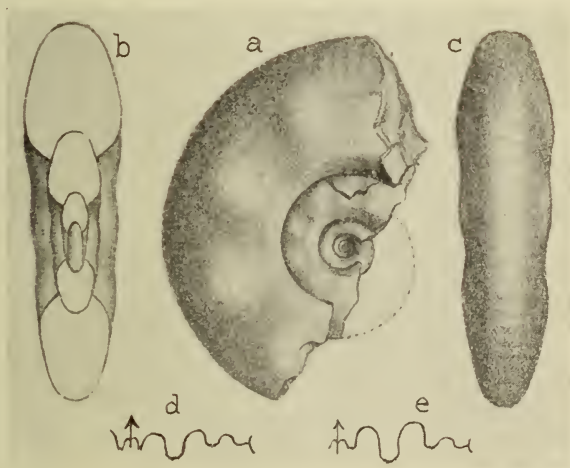


FIG. 14.—*Ophiceras* (*Acanthophiceras*) *gibbosum* (Griesbach). Lowest Eo-trias. Himalayas. (After Diener, 1897, pl. ix, figs. 4a–c and 3c, 5b.)

of Pastannah seem to connect the genus here discussed with *Glyptophiceras*; and Diener's *Ophiceras* cf. *gibbosum* (1913, p. 18, pl. i, figs. 3 and 10) represents such transitional forms.

***Ophiceras* (*Acanthophiceras*) *gibbosum*, Griesbach.**

Plate I, figs. 4a, b; Text-fig. 14.

1880, p. 111, pl. iii, fig. 10 (*Trachyceras* ?); holotype, Diener, 1915a, p. 211; Spath, 1930, p. 28.

DIAGNOSIS. Subplatygyral, subleptogyral, sublatumbilicate *Acanthophiceras*. Inner whorls smooth, compressed as in

Ophiceras; later whorls with prominent folds on the sides, but tending to disappear on the body-chamber. Periphery arched, umbilical slope high, as in *O. tibeticum*. Suture-line ceratitic (see figs. 14*d*, *e*).

MEASUREMENTS :

Griesbach's type (<i>vide</i> Diener) .	50	·36	·28	·35
Diener (1897, p. 108, pl. ix, fig. 7)	73	·37	·22	·37
C. 28528	81	·35	·32	·38

REMARKS. It is possible that the specimen included here belongs to a new species and represents a more extreme form than Griesbach's incomplete holotype; but since the examples figured by Diener apparently differ among themselves as well as from the holotype and from C. 28528, it is likely that the last comes within the range of variation of *O. (A.) gibbosum*. The inner whorls agree with Diener's smallest example (pl. ix, fig. 5*a*), but the folds following on that stage are even coarser than in the holotype. They persist to the end of the septate portion, at a diameter of 75 mm., although they degenerate and become more closely set on the last half-whorl, as in Diener's largest example; and it may be presumed that they had altogether disappeared on the body-chamber, which is missing, as they have in that specimen. Diener's fig. 7*a*, however, does not show the previous, coarsely-ribbed stage of Griesbach's type. The example here described is thus more *Xenodiscus*-like than any of Diener's figures, but, whilst it may be transitional from *O. (Acanthophiceras) gibbosum* to the true *Glyptophiceras himalayanum*, it cannot be united with any of those Kashmir "*Xenodiscus*" or *Ophiceras* described by Diener in 1913; and it is much closer to Griesbach's original *A. gibbosum* than to the "transitional form between *Ophiceras tibeticum*, Griesbach, and *Xenodiscus*, Waagen", figured by Diener (1913, pl. ii, figs. 2*a*, *b*).

The peculiarly curved folds, connecting the present form with *Ophiceras tibeticum* and *O. serpentinum*, are quite distinct from the recti-radiate costation of Frech's "*Celtites*" *radius* (1905, pl. xx, fig. 1), or the Flemingitid *Xenodiscoides perplicatus*, Frech sp., described below.

Welter's (1922, p. 105, pl. clvii, figs. 8, 9, pl. clviii, figs. 6, 7) Timor "*Ophiceras*" cf. *gibbosum* belong to the genus *Pseudo-flemingites*, and are of much later age than the present form.

HORIZON AND LOCALITIES. Lower Eo-trias, Otoceratan. Himalayas.

SPECIMENS :

C. 28528. Ath Nar, Pahlgam, Kashmir.

*Presented Geol. Surv. India, 1926. (Ex collection H. S. Bion, labelled *Ophiceras gibbosum*, Griesbach).*

Genus **GLYPTOPHICERAS**, Spath.

1930, p. 33.

GENOTYPE. *Xenodiscus æquicostatus*, Diener, 1913, p. 6, pl. ii, figs. 10a, b.



FIG. 15.—*Glyptophipiceras æquicostatum* (Diener). Lower Eo-trias. Kashmir. (After Diener, 1913, pl. ii, figs. 10a, b.)

DIAGNOSIS. More or less evolute, round-ventered Ophiceratidæ, with suture-line like *Ophiceras*, but with coarse, sigmoidal costation, tending to degenerate into striation.

DISTRIBUTION. Lower Eo-trias, Otoceratan (and Lower Gyronitan ?). Himalayas, East Greenland.

REMARKS. This genus is connected by numerous transitions with *Ophiceras* and *Acanthophipiceras*, but is less close to *Xenodiscoides* (group of *Xenodiscus perplicatus*, Frech), which is here referred to the family Flemingitidæ. The resemblance of forms like *G. himalayanum* (Griesbach), and especially of some East Greenland species, to the true rectiradiate *Xenodiscus* of Middle

Productus Limestone age, is considerable, but the holotype is quite distinct.

Such forms as *Celtites radiosus* and *C. fortis*, Koken, in Frech (1905, pl. xxii, figs. 1, 2), and "*Danubites*" *purusha*, Diener (1897, p. 30, pl. xv, figs. 14, 15), here referred to the genus *Anakashmirites*, Spath, morphologically connect the present genus with the family Kashmiritidæ, whilst some of Diener's *G. himalayanum* already foreshadow the later Xenoceltitids.

Glyptophteras ophioides, n. sp.

Plate XII, fig. 1.

(?) 1913. *Xenodiscus* cf. *ophioneus* (non Waagen sp.), Diener, p. 12, pl. ii, figs. 8, 9.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Glyptophteras*. Whorl-section elliptical, with narrowly arched venter and rounded umbilical slope. Blunt costation, closely-set on inner whorls, then wider and becoming approximate again on body-chamber. Slight constrictions across periphery. Suture-line ceratitic, as in *Ophiceras*.

MEASUREMENTS :

Holotype (C. 28539) . . . 50 .32 .24 .44

REMARKS. The Pastannah forms referred by Diener to Waagen's *Lecanites ophioneus* (based, perhaps, on worn Flemingitids), are probably closely related to, if not identical with, the species here described. *G. æquicostatum* (Diener) differs chiefly in being less loosely coiled; and *G. kashmiricum*, discussed below, is less distinctly costate. The holotype of the last, the specimen on which the present species is based, and a fragment of *G. himalayanum* (Diener, non Griesbach) were all labelled "*Xenodiscus himalayanus*", but whilst Griesbach's original differs in its costation and subtrigonal whorl-section, the Pastannah species (*G. pascoei*, Spath),¹ erroneously united by Diener with *G. himalayanum*, has much more distant and coarser costation than the species now discussed.

HORIZON AND LOCALITIES. Lower Eo-trias, "*Ophiceras* Beds". Kashmir.

SPECIMENS :

C. 28539. Pastannah, Kashmir.

Presented Geol. Surv. India, 1926.

¹ See p. 83.

Glyptophiceras kashmiricum, Spath.

Plate I, figs. 3a, b.

1930, p. 37.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Glyptophiceras*. Whorl-section elliptical, with narrowly arched venter and rounded umbilical slope. Blunt, wide folds on inner whorls, degenerating into irregular striæ and pleats, with constrictions across the venter. Suture-line unknown.

MEASUREMENTS :

C. 28540 (Holotype) . . . 28.5 .32 .28 .46

REMARKS. This species was based on Diener's *Xenodiscus* cf. *lissarensis* (1913, p. 5, pl. i, fig. 11) from the same bed, with an umbilicus of 49% of the diameter and a slightly smaller whorl-height and thickness. It is not identical with the original "*Danubites*" *lissarensis*, Diener (1897, p. 45, pl. xiv, figs. 8, 9, 11), unless the drawings are very inaccurate; for the coarse, straight ribbing of the *Anakashmirites*-like inner whorls, with their less compressed section, and the regular finer ribs of the outer whorls, are quite distinct from the ornamentation of *G. kashmiricum*, which shows much more resemblance to the Upper Eo-triassic "*Danubites*?" recorded by myself (1921, p. 349) from Spitsbergen, and described below under *Xenoceltites*. The comparison of these Arctic forms with Diener's (1895a, p. 15, pl. ii, fig. 6) doubtful, small *Ceratites minutus* (*non* Waagen), associated on the Isle of Russkij with *Ophiceras* cf. *sakuntala*, Diener, illustrates how easy it is to confuse the members of such homœomorphous stocks.

G. ophioides, sp. nov., described above, differs in its looser coiling and more distinct ribbing.

HORIZON AND LOCALITIES. Lower Eo-trias, Otoceratan (or Lower Gyronitan). Himalayas.

SPECIMENS :

C. 28540. Pastannah, Kashmir (labelled *Xenodiscus himalayanus*). Presented Geol. Surv. India, 1926.

Glyptophiceras pascoei, Spath.

1913. *Xenodiscus himalayanus*, Diener, p. 3, pl. ii, fig. 4? (*non Ophiceras himalayanum*, Griesbach). 1930, Spath, p. 36, pl. viii, figs. 1-7, 16.

DIAGNOSIS. *Glyptophiceras* resembling *G. kashmiricum*, but

with the ribbing of the inner whorls coarser and more distant, and persisting to a later stage.

MEASUREMENTS :

Holotype	54	·33	·25	·48
Diener (1913, pl. ii, fig. 4)	56	·29	..	·45
„ („ „ „ 3)	44	·32	·23	·41

REMARKS. Diener interpreted Griesbach's species rather widely, and we may well doubt whether any of his Pastannah examples agree with the Shalshal form. In any case the larger of his figured specimens, like a fragmentary example in the Collection from the same bed, differ in their more oval whorl-section with less pronounced and high umbilical rim; in their greatest whorl-thickness being nearer the middle of the side; and in the coarse ribbing of their early whorls, which persists to a diameter of about 50 mm. The ribbing is also of a different type, stronger and less regular, resembling that of *G. althothæ* (Diener, 1913, pl. ii, figs. 6, 11). Even the example from Pastannah in the Collection, consisting only of parts of two whorls, may possibly belong to the last-named or to an allied species. Waagen's "*Meekoceras*" *falcatum* (1895, p. 242, pl. xxxvi, fig. 4), with which Diener compared the species here discussed, is probably a homœomorphous and later offshoot of that smooth, radical stock which produced *Xenodiscoides* and other Flemingitids and Meekoceratids.

HORIZON AND LOCALITIES. Lower Eo-trias, "*Ophiceras* Beds". Kashmir.

SPECIMENS :

C. 28541. Pastannah, Kashmir.

Presented Geol. Surv. India, 1926.

Genus **VISHNUITES**, Diener, 1897, p. 83 (88).

GENOTYPE. *V. pralambha*, Diener, 1897, p. 88, pl. vii, figs. 4a-d.

DIAGNOSIS. Compressed, evolute, generally smooth Ophiceratidæ, with the suture-line of *Ophiceras*, but with an acute venter.

DISTRIBUTION. Lower Eo-trias, Upper Otoceratan to Lower Gyronitan. Himalayas, East Greenland.

REMARKS. There are only a few described forms of true *Vishnuites*, but the discovery of several new species in East

Greenland has made it possible definitely to characterize *Vishnuites* as including merely keeled offshoots of various forms of *Ophiceras*. Thus *V. wordiei*, Spath, in side view, is almost indistinguishable from certain *Acanthophiceras*, whilst the majority show greater resemblance to the associated discoidal and smooth species of *Lytophiceras*. The genus *Vishnuites*, as here understood, is thus not strictly monophyletic.



FIG. 16.—*Vishnuites* aff. *pralambha*, Diener. Lower Eo-trias. Kashmir. (After Diener, 1913, pl. iii, figs. 4a, b, differing from type in wider umbilicus with more pronounced border.)

"*Vishnuites*" *discoidalis*, Welter (1922, p. 138, pl. clxvii, figs. 1, 2), for which the genus *Metinyoites*, Spath, was proposed in 1930, and *Subvishnuites*, Spath, 1930 (for *S. welteri*, Spath = "*Vishnuites*" sp. Welter, 1922, p. 137, pl. xiii, figs. 3-5), are not directly related to the Lower Eo-triassic stock here discussed. The former is provisionally included in Inyoitinae, nov.,¹ considered to be a sub-family of Xenoceltitidæ; *Subvishnuites* resembles *Pseudoflemingites*, but has a tendency to fastigation of the periphery. The suture-line of these Timor forms is more advanced than those of the true Ophiceratids; and since *Pseudoflemingites* is connected by transitions with

¹ See p. 136.

undoubted Flemingitids and is later than the Ophiceratids, its probable keeled offshoot *Subvishnuites* is also removed from the present family.

Genus **SUBINYOITES**, Spath.

1930, pp. 30, 90.

GENOTYPE. *Inyoites kashmiricus*, Diener, 1913, p. 21, pl. iii, figs. 8a-c.



FIG. 17.—*Subinyoites kashmiricus* (Diener). Lower Eo-trias, Kashmir. (After Diener, 1913, pl. iii, figs. 8a-c.)

DIAGNOSIS. Compressed, subangustumbilicate Ophiceratidæ, with blunt radial folds and acute venter. Suture-line ceratitic, with high first, and low second, lateral saddles, and auxiliaries forming a serrated line, as in many *Ophiceras*.

DISTRIBUTION. Lower Eo-trias, Lower Gyronitan ? Kashmir.

REMARKS. The species on which this genus is based is obviously closely related to *Vishnuites*, and represents an acute development of a coarsely ribbed member of the Ophiceratidæ.

Inyoites, with a very different ornamentation and suture-line, and a high, hollow keel, bears only superficial resemblance to the genus here discussed.

? Genus **PROTOPHICERAS**, Hyatt.

1900, p. 556.

GENOTYPE. *Danubites nicolai*, Diener, 1895*a*, p. 19, pl. ii, figs. 1*a-c*.

DIAGNOSIS. *Ophiceratidæ* having evolute compressed whorls with flattened sides and arched venter. With faint ribbing on



FIG. 18.—*Protophiceras nicolai* (Diener). Upper Eo-trias. Vladivostok, E. Siberia. Side- and peripheral views and suture-line of holotype. (After Diener, 1895, pl. ii, figs. 1*a-c*.)

inner whorls, and distant blunt costæ on inner lateral area of outer whorls, drawn forward and weakening peripherally. Suture-line comparatively simple, ceratitic (see fig. 18*c*).

DISTRIBUTION. Eo-trias. Ussuri, Eastern Siberia.

REMARKS. Hyatt, when creating this genus, referred it (with the true *Ophiceras*) to Prionitidæ; but this family is here restricted to those derivatives of Meekoceratidæ or Dagnoceratidæ in which a widening angular (tabulate) periphery is combined with acquisition of lateral costæ or tubercles. Diener (1915*a*, p. 235) considered *Protophiceras* to be synonymous with *Xenodiscus*, Waagen, but it has already been shown that this

genus (which ought to be used only for the Permian *X. plicatus*, originally described by Waagen, even if a doubtful form) has been made to include a number of more-or-less homœomorphous costate developments of other stocks, e. g. of *Ophiceras* (*Glyptophticeras*), or of Flemingitids (*Xenodiscoides*).

In its characteristic and very pronounced forward projection of the ribs *Protophticeras nicolai* resembles *Xenoceltites russkiensis*, nom. nov. (= *Ceratites minutus*, Diener, non Waagen; 1895a, p. 15, pl. ii, fig. 6), but it is to be noted that Diener already separated his two Siberian forms into different groups, namely the obsoleti ("Danubites") and the circumplexi ("Ceratites"). In the genus *Protophticeras* there is no trace of the characteristic constrictions of *Xenoceltites*. The earlier *Glyptophticeras* differs in its type of ribbing, which is more sigmoidal and not thickened at the inner end; but attention has already been directed (p. 82) to the similarity between such forms as *G. himalayanum* (Griesbach) and the Xenoceltitids.

"*Xenaspis*" *marcoui*, Hyatt and Smith (1905, p. 116, pl. vii, figs. 26-33), apparently somewhat intermediate between *Protophticeras* and *Preflorianites*, may be another offshoot of the same (*Dieneroceras*?) radical which also had its "degenerate" branches (e. g. "*Lecanites*" *knechti*, Hyatt and Smith, 1905, p. 138, pl. ix, figs. 11-16). If this view prove correct, *Protophticeras* may have to be transferred to the Upper Eo-triassic Xenoceltitidæ.

The only form in the Collection that may be referable to *Protophticeras* is an incompletely-known species from Timor (represented by two specimens, Nos. C. 33795-6), with resemblance to the smaller of Welter's two examples of *Ophiceras* cf. *gibbosum*, non Griesbach (1922, p. 105, pl. clviii, figs. 6, 7). The larger specimen (pl. clvii, figs. 8, 9) is apparently a *Pseudoflemingites*, allied to *P. tenuis* and *P. crassicosatus* (Welter); but the smaller example, perhaps only on account of its partial covering of matrix, seems to belong to the same stock as the slightly more evolute Toeboelopo specimens with a similarly high, Ophiceratid, umbilical slope, but whorl-shape and coiling different from that of *Pseudoflemingites*. But by their suture-lines, the examples may also be considered to resemble those Anisian "*Xenaspis*" figured by Welter, that connect Gymnitidæ with the Ophiceratid root-stock. As the horizon is unknown (they are from a yellow limestone, not from the red *Pseudoflemingites* bed), it seems preferable at present to refer them but tentatively to *Protophticeras*.

III. Super-family MEEKOCERATIDA, Waagen, 1895, p. 204, emend.

DIAGNOSIS. Typically smooth, more-or-less discoidal shells with rounded or truncate peripheries and ceratitic suture-lines, but producing globose, carinate, or ribbed offshoots, occasionally also complicating or simplifying the suture-lines.

REMARKS. The following twelve families have apparently little in common except their derivation from *Ophiceras* and the absence of tuberculation, and it is only for convenience of arrangement that they are now grouped together in one super-family. The feebly ornamented Prionitidæ and Dinaritidæ could also be taken to be more appropriately referred to the Meekoceratida than to their highly sculptured and generally tuberculate descendants, the Ceratitida. These two small families, however, are so intimately connected with the larger units Sibiritidæ and Tirolitidæ, respectively, that separation into two distinct super-families is inadvisable.

A. Family GYRONITIDÆ, Waagen, emend.

1895, p. 275 (as sub-family) ; Hyatt, 1900, p. 556.

DIAGNOSIS. Evolute, discoidal ammonites with flattened sides and rounded or truncate periphery. Suture-line ceratitic to sub-goniatitic.

REMARKS. Hyatt used the name Gyronitidæ only incidentally in the description of the families Flemingitidæ and Prionitidæ, but included *Gyronites* itself, with a heterogeneous assemblage of other stocks in the Meekoceratidæ. In 1905, Hyatt and Smith (p. 145) considered *Gyronites* to be merely a sub-genus of the (probably much later) genus *Meekoceras*. The family name *Gyronitidæ*, first used by Waagen as a sub-family name, is now reinstated for a group of genera which are connected by transitions with *Gyronites*, and are characteristic of the Gyronitan age as defined above.

Gyronitidæ may be briefly defined as somewhat intermediate between the Ophiceratidæ, in which there is only exceptionally a tendency to truncation of the periphery (*e.g.* "*Ophiceras*" *dharma*, Diener), and later families, especially Flemingitidæ, with only the lateral ornamentation more pronounced. The Kymatitinæ, with involute whorls combined with a truncate

periphery, may be included here as a sub-family. The Paranoritidæ, in which the umbilicus tends to close, and the venter becomes often sharpened, are a parallel stock.

1. Sub-family GYRONITINÆ, Waagen, s.s.

1895, p. 275.

DIAGNOSIS. Gyronitidæ, as defined above, having a more or less open umbilicus and ceratitic suture-lines.

Genus GYRONITES, Waagen, 1895, p. 288.

GENOTYPE. *G. frequens*, Waagen, 1895, p. 292, pl. xxxvii, figs. 2a, b only (lectotype).

DIAGNOSIS. Substenogyral, to platygyral, subleptogyral, sublatumbilicate to subangustumbilicate Gyronitidæ. Venter tabulate, sides flat, with faint striæ of growth, occasionally with strigation near, and on, the periphery. Umbilical rim rounded. Suture-line ceratitic, with generally a distinct auxiliary series.

DISTRIBUTION. Lower Eo-trias, Gyronitan. Salt Range.

REMARKS. The genus is here restricted to Waagen's Section "*Biangulares*", but does not include the Siberian form named by Waagen "*Gyronites*" *mojsisovicsi* (= *Xenodiscus schmidtii*, Mojsisovics, pars, 1886, pl. xi, fig. 11 only), which is here interpreted as a somewhat homœomorphous offshoot of a much later stock with entirely different developmental stages. Waagen's second section "*Semi-Rotundati*" may be partly *Glyptophiceras* ("*Gyronites*" *plicosus*, Waagen, 1895, pl. xxxviii, figs. 11a, b), partly *Xenodiscoides* ("*Gyronites*" *rotula*, Waagen, *ibid.*, figs. 4, 5, non 3?). "*Gyronites*" *vermiformis*, Waagen (1895, p. 305, pl. xxxix, fig. 1), and some of his *Lecanites* (at least the species that are based on unworn examples), are here considered to belong to a more primitive stock (*Lytophiceras* and *Gyrophiceras*, gen. nov.),¹ which gave rise to Gyronitidæ, but itself persisted unchanged, and probably also produced the later Flemingitidæ. *Gyrolecanites*, gen. nov.² (for *Lecanites impressus*, Waagen), is another development of the same stock, characterised by its very simple suture-line.

"*Gyronites*" *whiteanus*, Waagen, a Meekoceratid, is discussed below under *Wyomingites*.

¹ See p. 93.

² See p. 95.

Gyronites frequens, Waagen.

Fig. 19.

1895, p. 292, pl. xxxvii, figs. 1-4 (lectotype, figs. 2*a*, *b*); Diener, 1915*a*, p. 196.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Gyronites*. Sides slightly convex, umbilical wall rounded, venter tabulate and bordered by sharp edges. Suture-line

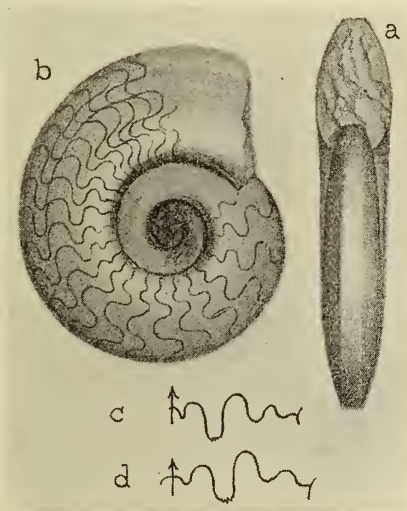


FIG. 19.—*Gyronites frequens*, Waagen. Lower Eo-trias. Khoora, Salt Range. *a*, Ventral view of a large example with almost complete body-chamber. *b*, Side-view of lectotype, with crowded suture-lines at beginning of body-chamber. *c*, External suture-line of same, and *d* of another specimen. (After Waagen, 1895, pl. xxxvii, figs. 1*b*, 2*a*, *b*, 3*b*.)

ceratitic, with short external and deep lateral lobes. Auxiliaries forming one broad and shallow lobe reaching down to the umbilical suture.

REMARKS. This easily recognizable species is fairly common, and occurs in blocks crowded with its shells. The available material, however, is insufficient for tracing its variability. *Gyronites* (?) *psilogyrus*, Waagen, sp. (1895, p. 280, pl. xxxix, figs. 5*a-c*), was said to differ in suture-line, but may be identical,

whereas *G. superior*, Waagen (1895, p. 294, pl. xxxvii, figs. 6a, b) is more compressed, discoidal and more involute. *G. (?) nangaensis*, Waagen (1895, p. 297, pl. xxxvii, figs. 5a-c), shows distinct ribbing, besides differing from the other species of *Gyronites* in the absence of auxiliaries. Frech (1905, pls. xiii and xxii) referred *G. frequens* to the genus *Ophiceras*, together with *Gyrophiceras gangeticum*, *G. vermiforme* (Waagen) and species of *Ambites* and *Kymatites*. But this comprehensive interpretation of Griesbach's genus is not now advisable. While *Gyronites* may retain the strigation of the ancestral *Ophiceras*, the stages of coiling passed through in the ontogeny of *Ophiceras*, with its high umbilical wall, are entirely different from those of the Gyronitids.

HORIZON AND LOCALITIES. Lower Eo-trias, Gyronitan, Lower Ceratite Limestone. Salt Range.

SPECIMENS :

- C. 10419.** Chideru, Salt Range. Eleven specimens out of one block. *Koken Coll., purchased 1905.*

***Gyronites planissimus* (Koken MS.), sp. nov.**

Plate VIII, figs. 4a, b.

TYPE. B.M. no. C. 10447, ex Koken Coll. (*Xenodiscus planissimus*).

DIAGNOSIS. Subplatygyral, leptogyral, sublatumbilicate *Gyronites*. Sides almost plane; venter tabulate; umbilical wall distinct, rounded. Suture-line ceratitic, as in *Gyronites superior*, Waagen.

MEASUREMENTS :

Holotype 90 (80) . .36 . .15 . .36

REMARKS. The last quarter of a whorl in the holotype belongs to the body-chamber. This species differs from *Gyronites superior*, Waagen, in its wider umbilicus and still more flattened sides; also in its less narrow saddles. In the last respect there is more resemblance to *G. (?) psilogyrus* (Waagen) above mentioned, but the second lateral saddle is well-defined in *G. planissimus*, even at a small diameter, and the shape is more compressed. *Gyronites frequens* is also less flattened laterally, and does not appear to grow to similar large dimensions. Koken considered this species to be a *Xenodiscus*, but in his collection that generic name is applied to various Gyronitids (*Prionolobus*), *Paranorites* and Flemingitids (*Xenodiscoides*).

HORIZON AND LOCALITIES. Lower Eo-trias, Gyronitan. Salt Range.

SPECIMENS :

C. 10447. Lower Ceratite Limestone ("zone of *Prionolobus rotundatus*") of Virgal, Salt Range.

Koken Coll., purchased 1905.

? Genus **GYROPHICERAS**, n. gen.

GENOTYPE. *Lecanites gangeticus* (de Koninck), Waagen, 1895, p. 277, pl. xxxix, figs. 4a-c.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate Gyronitidæ. Venter arched; sides convex; umbilical wall

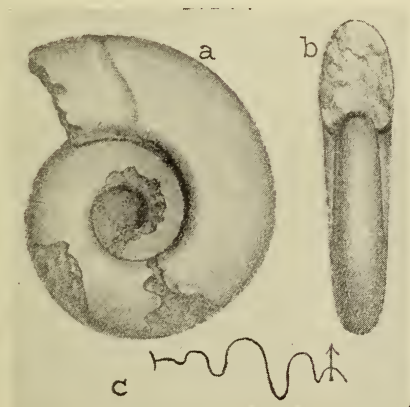


FIG. 20.—*Gyrophiceras gangeticum* (de Koninck). Lower Eo-trias. Vurcha, Salt Range. (After Waagen, 1895, pl. xxxix, figs. 4a-c.)

rounded. Suture-line subgoniatitic, with shallow external and deep lateral lobes, as in *Gyronites*, but auxiliaries may be absent.

DISTRIBUTION. Lower Trias, Gyronitan and Flemingitan. Salt Range.

REMARKS. Hyatt and Smith (1905, p. 138) referred to the "group of *Lecanites gangeticus*", a minute form from the *Meekoceras* Beds of the Inyo Range ("*Lecanites*" *knechti*), which, to judge by the proportions of its saddles, may have little to do with the present genus, and certainly is not a true *Lecanites*. The Californian species, however, referred to below as possibly a Flemingitid, cannot be definitely identified from the figures, although Diener (1915a, p. 228) put it into the

Anisian genus *Proavites*, Arthaber, here provisionally considered to be a simplified Dagnoceratid.

Diener, in 1897 (p. 147), accepted Waagen's interpretation of "*Lecanites*" and described two new forms from the "*subrobustus*" beds of the Himalayan Lower Trias. In 1909 (in v. Krafft and Diener, p. 74) he referred one of these to the group of the evolute "*Meekoceras disciforme*" (v. Krafft = *Gyronites*, Waagen), and the other to *Proavites*. They are only doubtfully referred to Gyronitidæ, and will be discussed below under *Catalecanites*, n. gen. (see p. 103).

Gyronites vermiformis, Waagen, the form figured by Frech (1905, pl. xiii, fig. 2) under that specific name, as well as the Timor species described below, seem to show that *Gyrophiceras* ranged from the *Gyronites* Beds up to the top of the Lower Eo-Trias. It continues the *Ophiceras* type, but tends to become reduced; whereas *Dieneroceras*, a primitive Flemingitid with simple suture-line, probably gave rise to a number of virile stocks.

***Gyrophiceras* aff. *vermiforme* (Waagen).**

1895, p. 305, pl. xxxix, fig. 1; Diener, 1915a, p. 197 (*Meekoceras* [*Gyronites*]).

DIAGNOSIS. Sublatumbilicate *Gyrophiceras*, with subplatygyral, subleptogyral coiling. Whorl-sides almost parallel, smooth; venter narrowly arched; umbilical wall low and evenly rounded. Suture-line simple, ceratitic, as in *Gyronites* or *Ophiceras*, with deep first lateral lobe.

MEASUREMENTS :

Holotype	.	.	.	58	.	·36	.	·21	.	·38
C. 33811	.	.	.	46	.	·35	.	·20	.	·41
C. 33812	.	.	.	48	.	·33	.	·19	.	·44

REMARKS. The seventeen Timor examples, here provisionally included in this species, all came out of blocks that contained no other ammonites. On the other hand, of many blocks of the yellow "*Meekoceras* limestone", none has yielded the present species; and since Welter did not describe anything like it, *Gyrophiceras* aff. *vermiforme* may be assumed to be confined to a horizon in the Lower Trias, lower than any yet known from Timor, but corresponding in age to the Lower Ceratite sandstone of the Salt Range. There is some variability among the seventeen examples, especially in whorl-thickness and umbilication, but they are evidently members of

one species-group. If I do not definitely identify the Timor form with Waagen's Salt Range species, it is chiefly because the latter has a narrower external saddle, and because the same author's "*Lecanites*" *planorbis* (p. 278, pl. xxxix, figs. 3a-c) with a smaller umbilicus may be equally closely related. It is probable that the indistinctness of the second lateral saddles in the drawings of the suture-lines of both these species is due merely to defective preservation, also the absence of tothing of the lobes.

HORIZON AND LOCALITIES. Lower Trias, Flemingitan. Salt Range; Timor.

SPECIMENS.

C. 33811-28. Toeboelopo, Timor. *M.E. Walsh Coll.*, 1930.

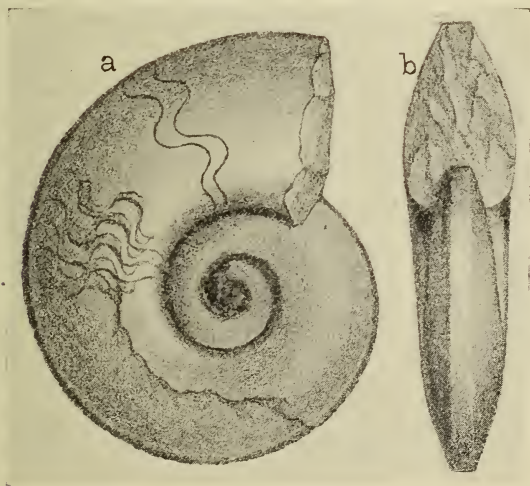


FIG. 21.—*Gyrolecanites impressus* (Waagen). Lower Eo-trias. Salt Range. (After Waagen, 1895, pl. xxxvii, figs. 7a, b.)

Genus **GYROLECANITES**, n. gen.

GENOTYPE. *Lecanites impressus*, Waagen, 1895, p. 286, pl. xxxvii, figs. 7a, b; Diener, 1915a, p. 228 (*Proavites*).

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate Gyronitidæ. Venter tabulate; sides gently convex; umbilical wall rounded, but abrupt. Suture-line simple, goniatic, with the second lateral saddle at the umbilical border.

DISTRIBUTION. Lower Eo-trias, Gyronitan. Salt Range.

REMARKS. It may seem rash to base a new genus on a species known only by one of Waagen's figures, and the fact that both his specimens are firmly embedded in the matrix may make the accuracy of the restored drawings suspect. The simple suture-line, however, is probably not entirely due to weathering, and even if slight denticulations should occur at the base of the principal lobe, yet the position of the elements in the suture-line is sufficiently characteristic to justify the separation of the present form from *Gyronites*. *Lecanites psilogyrus* has already been referred to as probably identical with *Gyronites*, and *L. undatus* (Waagen, 1895, p. 281, pl. xxxviii, fig. 2) may be only the worn inner whorls of *Prionolobus*.

Genus PRIONOLOBUS, Waagen.

1895, p. 306.

GENOLECTOTYPE. *P. atavus*, Waagen, 1895, p. 309, pl. xxiv, figs. 4a, b.
Here chosen.

DIAGNOSIS. More-or-less evolute, discoidal Gyronitidæ, with rounded or tabulate venter, and tendency to involution. Suture-line ceratitic, as in *Gyronites*.

DISTRIBUTION. Middle Eo-trias, Upper Gyronitan and Lower Flemingitan. Salt Range, Himalayas, Timor.

REMARKS. Frech (1905, p. 2, pl. xxii), when emending Waagen's genus *Prionolobus*, made it comprise *Paranorites*, *Koninckites* (*partim*), some "*Aspidites*", and most species of Waagen's "*Meekoceras*". The last, in Waagen's interpretation, is too varied an assemblage; the *magnumbilocatus* group certainly belongs to those allies of *Prionolobus volutus*, for which the generic name *Paranorites* is here adopted. The true *Prionolobus* in the restricted sense comprises only the *atavus* group, which is here taken to include involute forms like *Prionolobus rotundatus*, Waagen (= *Meekoceras waageni*, v. Krafft, 1909, p. 16 = *M. rotundiforme*, Diener, 1915a, p. 194), on the one hand, and "*Koninckites*" *impressus*, Waagen, on the other. "*Meekoceras*" *planulatum*, Waagen, probably also belongs to the genus here discussed, and it is important to note that the young of such forms as *Prionolobus lilangensis*, v. Krafft (in v. Krafft and Diener, 1909, p. 23, pl. i, figs. 2a, b, c, lectotype), and *P. hodgsoni*, Diener (in v. Krafft and Diener, 1909, p. 26, pl. iii, fig. 2), are more involute than *Gyronites*.

The Californian "*Prionolobus*" *jacksoni* and "*P.*" *waageni*

Hyatt and Smith (1905, pl. lxii, figs. 11–21, and pl. lxxvii, figs. 3–8), are referred to below under *Submeekoceras* n. gen. They are difficult to separate generically from “*Flemingites*”? *russelli* on the one hand, but, on the other, they belong to the stock that gave rise to Arctoceratids and other later families.

“*Meekoceras*” *hanieli*, Welter (1922, p. 131, pl. xi, figs. 3–5), with more advanced suture-line, shows some resemblance to the Flemingitid genus *Pseudoflemingites* (see p. 116), but, with “*M.*” *wanneri*, Welter, might also be compared to the unrelated *Wyomingites*; that is to say, homœomorphous forms were produced in the three successive families: Gyronitidæ, Flemingitidæ and Meekoceratidæ.

Waagen (1895, p. 320, pl. xxxv, figs. 5a–c) referred de Koninck’s *Ceratites buchianus*, based on a “scarcely recognizable drawing”, to the genus *Prionolobus*. This is probably correct, as mentioned below (p. 101), judging by some of de Koninck’s syntypes. One of the examples mentioned by this author (1863, p. 13) as not identifiable, also in the Geol. Soc. Coll. (Dr. A. Fleming Coll.), is labelled “*Ceratites buchianus*, de Kon. Punjaub”, and “Prod. Limest. Kaffir Kote”. But this is merely a natural, median section, exposed on the surface of a small slab of rock. Moreover, it is replaced by crystalline calcite, and is thus quite unrecognizable.

The present genus probably also includes some poor impressions (C. 35962–4) in the Lower Triassic nodules with fishes from Anaborano and Ambara-Karaka, in Northern Madagascar (E. I. White Coll., 1929); they are comparable to *P. wanneri*, described below.

***Prionolobus orbis* (Koken MS.), sp. nov.**

Plate II, fig. 4.

TYPE. B.M., C. 10437, *ex* Koken Coll. (*Koninckites orbis*, Koken MS.).

DIAGNOSIS. Subplatygyral, subleptogyral, sublatumbilicate *Prionolobus*. Sides flattened, venter narrowly rounded, indistinctly tabulate. Falciform ribbing (imperfectly preserved on cast). Suture-line ceratitic, as in *P. atavus*.

REMARKS. This species differs from the genotype, *P. atavus*, merely in proportions, its umbilicus being 35% of the diameter, with a whorl height of 37%, as against 31% and 40%, respectively, in Waagen’s form. The falcoid ribbing, resembling that of *Paranorites ambiensis*, Waagen, is neither found in

P. atavus nor in *P. rotundatus* (Waagen, 1895, p. 310, pl. xxxiv, figs. 1-3). The last (with dimensions: 70, .46, .23, .25; 57, .46, .23, .21) is still further removed than *P. atavus* from the form here described, but its suture-line is identical. *P. sequens*, Waagen (1895, p. 312, pl. xxxiv, figs. 5a-c), is also undoubtedly very close to *P. orbis*, but has an umbilicus of only 27% of the diameter. *P. indoaustralicus* (Wanner, 1911, p. 183, pl. vii, fig. 3) also differs merely in proportions, its umbilicus and whorl-height being 32% and 38% respectively.

"*Meekoceras*" *magnumbilitatum*, Waagen (1895, p. 251, pl. xxxiii, figs. 3a, b), similarly resembles the present species, but is less evolute; and the characteristic saw-like auxiliaries of *Prionolobus* are not straight in Waagen's form.

HORIZON AND LOCALITIES. Ceratite Marls, Upper Gyronitan. Salt Range.

SPECIMENS:

C. 10437. Holotype. Chideru, Salt Range.

Koken Coll., purchased 1905.

***Prionolobus indoaustralicus* (Wanner).**

1911, p. 183, pl. vi, fig. 1; pl. vii, fig. 3 (*Meekoceras*); Welter, 1922, p. 129.

DIAGNOSIS. *Prionolobus*, resembling *P. orbis*, but with elements of the suture-line having different proportions, notably the external saddle being wider and the serrated auxiliaries longer. There are slight differences in measurements from *Prionolobus orbis*.

MEASUREMENTS:

Holotype (Wanner, p. 183).	. 74	.38	.19	.32
C. 33829 . . . . .	. 120	.36	.17	.36

REMARKS. This species is probably merely the Timor equivalent of the Salt Range form described above as *P. orbis*; and *P. atavus* (Waagen), the genotype of *Prionolobus*, is also closely related, but more involute. *P. hanieli* (Welter) differs very slightly in suture-line and in the corrugation of the whorl-sides, but belongs to the same species-group.

HORIZON AND LOCALITIES. Lower Eo-trias, Flemingitan. Timor.

SPECIMENS:

C. 33829. Toeboelopo, Timor.

M. E. Walsh Coll., 1930.

Prionolobus hanieli (Welter).

1922, p. 131, pl. clxv, figs. 1, 2 (3-5) (*Meekoceras*).

DIAGNOSIS. *Prionolobus* resembling *P. indoaustralicus* (Wanner), but with bases of lobes of the suture-line all in a line, and with more distinct corrugations.

MEASUREMENTS :

Lectotype (Welter, figs. 1, 2)	. 69	.38	.19	.35
Welter (pl. clxv, figs. 3, 4)	. 63	.38	.16	.35
C. 33831	. 66	.38	.18	.37

REMARKS. The example now selected as type may be specifically different from *P. indoaustralicus*, since Welter separated them; but his second example and the Timor specimen listed above (no. C. 33831) do not seem to me to differ from the inner whorls of Wanner's species. Unfortunately, the material before me is insufficient; for while there are numerous representatives of the more involute *P. wanneri*, the evolute extremes, *P. indoaustralicus* and *P. hanieli*, seem much rarer. They clearly belong, however, to the same species-group.

HORIZON AND LOCALITIES. Lower Eo-trias, Flemingitan. Timor.

SPECIMENS :

C. 33830-31. Toeboelopo, Timor. *M. E. Walsh Coll.*, 1930.

Prionolobus wanneri (Welter).

1922, p. 129, pl. clxiv, figs. 17, 18 (lectotype); pl. clxv, figs. 18, 19 (*Meekoceras*).

DIAGNOSIS. *Prionolobus* resembling *P. hanieli* (Welter) and *P. indoaustralicus*, but more involute, especially in the young. Adult tending to excentrumbilication.

MEASUREMENTS :

Lectotype (Welter, pl. clxiv, figs.				
17, 18)	. 115	.43	.17	.33
Paratype (Welter, pl. clxv, figs.				
18, 19)	. 47	.40	.17	.28
C. 33832	. 64	.39	.17	.30

REMARKS. Welter compared this species to *Gyronites evolvens*, Waagen (1895, p. 295, pl. xxxv, fig. 7); and the suture-lines may be identical, if Waagen's fig. 7a is correct. On the other

hand, the wide and subdivided external lobe shows that *P. wanneri* (or *P. evolvens*) is distinct from the earlier *Gyronites*. Some of the more involute young of the present species are almost indistinguishable from *Ambites discus*, described below (fig. 23); but this is believed to be a homœomorphous offshoot of the earlier *Gyronites*. The umbilicus in *P. wanneri* has a tendency to become excentric; and according to whether this uncoiling appears earlier or later, there results a number of forms with different measurements for the width of the umbilicus. These seem to me more naturally classed in a single species-group (*P. wanneri*) than referred to allied forms, like *P. lilangensis*, which happen to show similar dimensions.

HORIZON AND LOCALITIES. Lower Eo-trias, Flemingitan. Timor.

SPECIMENS :

- C. 33832-9, 929-48, 962. Toeboelopo, Timor. (involute var.).
M. E. Walsh Coll., 1930.
- C. 33963-8, 34065-8, 34070-4. Toeboelopo, Timor.
Same Coll.
- C. 33840-928. Nifoekoko, Timor.
Same Coll.
- C. 37319-20. Toenioen Eno, Timor.
Same Coll.
- C. 34075 (?) (= *Meekoceras jolinkense*, Welter, non Krafft),
 Toeboelopo. *Same Coll.*

***Prionolobus impressus* (Waagen).**

1895. *Koninckites impressus*, Waagen, p. 263, pl. xxxv, figs. 6a, b (holotype).

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Prionolobus*. Sides flattened, smooth; venter tabulate; umbilical wall vertical. Suture-line ceratitic, as in *P. rotundatus*.

REMARKS. Waagen's type, at a diameter of 48 mm., has an umbilicus of 25%; in the only example described here the width of the umbilicus is only 23% of the diameter (40 mm.). The specimen was labelled (by the late Mr. G. C. Crick) *Prionolobus rotundatus*, Waagen, and it agrees with that species in general aspect and suture-line; but in its well-defined umbilical edge, more angular periphery and greater compression of the whorls near the periphery, it shows closer affinity with *P. impressus* than with *P. rotundatus*. The presence of one or two slightly larger teeth in the saw-like auxiliary series, which made Waagen refer this species to *Koninckites* rather than to *Prionolobus*, is not here considered to be of generic importance.

One of the syntypes of *Ceratites buchianus*, de Koninck (1863, p. 13, pl. vi, fig. 4), remaining in the Fleming Collection differs from the present species merely in having a larger umbilicus (30% at 50 mm. diameter); but it is more discoidal than the form figured by Waagen under the name of *Prionolobus buchianus*. Unfortunately, it is too poorly preserved to be figured or to be described separately and another example (see p. 97) is quite unrecognizable.

HORIZON AND LOCALITIES. Lower Ceratite Marls, Upper Gyronitan. Salt Range.

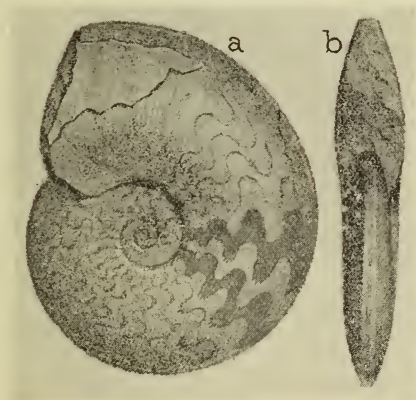


FIG. 22.—*Prionolobus impressus* (Waagen). Lower Eo-trias. Virgal, Salt Range. (After Waagen, 1895, pl. xxxv, figs. 6a, b.)

SPECIMENS :

C. 26690. Transferred Mus. Pract. Geol., 1880.

Presented by Dr. Fleming, labelled "Carb. Limest.
Ceratites sp."

C. 35092, 9434. Vurcha and Kaffir Kote (two of de Koninck's syntypes of *Ceratites buchianus*).

Dr. Fleming, ex Geol. Soc. Coll., 1911.

***Prionolobus lilangensis* (v. Krafft).**

Plate IV, fig. 4.

1909. *Meekoceras lilangense*, v. Krafft (in v. Krafft and Diener), p. 23, pl. i, figs. 2a-d (lectotype, here chosen), 1, 3, 5-7; pl. xiv, figs. 1, 2.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Prionolobus*. Sides almost flat and smooth, with faint

sigmoidal lines of growth on test; venter tabulate, sometimes slightly compressed so as to produce a "bottle-shaped" cross-section. Suture-line with simple external lobe and short, saw-like series of auxiliaries (Pl. IV, fig. 4).

MEASUREMENTS :

Krafft and Diener, 1909, p. 24	.	52·5	·47	·17	·22
Ditto	.	at 22·3	·50	·18	·18
Lectotype (<i>ibid.</i> , pl. i, fig. 2)	.	44	·46	·23	·22

REMARKS. This species was obtained from five different layers in the lower half, as well as "above the middle", of the three feet of "*Meekoceras*" Beds at Lilang, and it is replaced in the upper layers by *Koninckites krafftii*, described below. *Prionolobus lingtiensis*, v. Krafft sp. (in v. Krafft and Diener, 1909, p. 25, pl. ii, figs. 1a-d), differs from *P. lilangensis* in its more distinct striation, and *P. hodgsoni*, Diener sp. (1897, p. 133, pl. vi, figs. 1a-c), is more involute. Of the Salt Range species, *P. impressus* (Waagen), with very similar whorl-shape, differs merely in details of its suture-line, notably in the simple external lobe; whilst *P. sequens* and *P. rotundatus* have slightly different proportions.

HORIZON AND LOCALITIES. Lower Eo-trias, Gyronitan. Himalayas.

SPECIMENS :

C. 28537. One mile north of Lilang, Spiti. (Collected and determined by A. v. Krafft.)

Presented Geol. Survey India, 1926.

Genus **AMBITES**, Waagen.

1895, p. 151; Diener, 1915a, p. 30.

GENOTYPE. *A. discus*, Waagen, 1895, p. 152, pl. xxi, figs. 5a, b, c.

DIAGNOSIS. Gyronitidæ with compressed, discoidal shells; with moderately small umbilicus; tabulate venter; and subgoniatitic suture-lines.

DISTRIBUTION. Flemingitan, Ceratite Marls. Salt Range.

REMARKS. This genus is close to *Gyronites*, with which it occurs (Fritsch, 1902, p. 53), and to *Prionolobus*, as here restricted, and may be considered to be transitional between the Gyronitidæ and Paranoritidæ, whose periphery is becoming sharp, on the one hand, and the more involute Kymatitinæ on the other. Frech (1905, p. 2 appended to pl. xxii) included *Ambites* in *Ophiceras*, which he identified with *Gyronites*, but this is a

far too comprehensive interpretation of widely separated forms. Similarly v. Krafft's reference of *Ambites* to *Meekoceras* (in v. Krafft and Diener, 1909, p. 47) is not here accepted, but this author recognized the close affinity of his "*Meekoceras*" *disciforme* (p. 45, pl. iii, figs. 6a-c—the lectotype here chosen), with *Ambites discus*, and pointed out that *Ambites magnum-bilicatus*, Waagen, cannot be satisfactorily distinguished from *A. discus*.

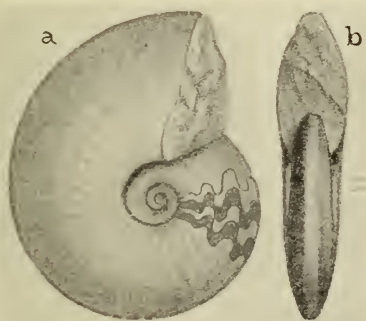


FIG. 23.—*Ambites discus*, Waagen. Eo-trias (Ceratite Marls). Amb, Salt Range. (After Waagen, 1895, pl. xxi, figs. 5a, b.)

Ambites rupestris, Waagen (1895, p. 155, pl. viia, fig. 10), which was listed by Diener (1915a, p. 30) as "gen. ind. sp. ind.", is based on a worn example, but the septal sections of its last third of a whorl show that there must have been a distinct second lateral saddle, so that it may well belong to the genus *Ambites*.

? Genus CATALECANITES, nov.

GENOTYPE. *C. planus*, sp. nov. = *Lecanites* sp. ind., Diener, 1897, p. 148, pl. xxiii, figs. 2a-c.

DIAGNOSIS. More-or-less evolute, discoidal, smooth ammonites with greatly compressed whorls, tabulate venter and distinct umbilical rim. Suture-line goniatitic, but with general aspect of that of *Gyronites*.

DISTRIBUTION. Lower Eo-trias, Flemingitan. Himalayas.

REMARKS. This genus may possibly represent a reduced Flemingitid offshoot rather than a simplified member of the *Prionolobus*-stock, as is suggested by its resemblance to *Flemingites rohilla*, Diener (1897, p. 93, pl. xxiii, fig. 1), and the fact

that "*Lecanites*" *sisupala*, Diener (1897, p. 147, pl. xxiii, fig. 3), with equally goniatitic suture-line, shows radial *Xenodiscoides*-like folds on the outer whorls. There can, however, be no affinity of this form with the Anisian *Proavites*, Arthaber.

Flemingites prænuntius, Frech, referred to below and considered by its author to be as assignable to "*Ophiceras*" (*Gyronites*) as to *Flemingites*, has only weakly-denticulated lobe bases, but is closely similar to *Catalecanites*. It seems probable

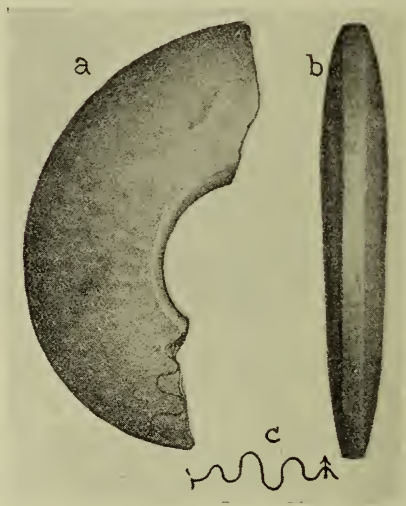


FIG. 24.—*Catalecanites planus*, sp. nov. (= "*Lecanites*" sp. ind., Diener, 1897, pl. xxiii, figs. 2a-c). Lower Eo-trias, Flemingitan. Himalayas. (After Diener.)

that Flemingitids, like Gyronitids, had their simplified offshoots with a goniatitic suture-line; but on account of its smoothness, *Catalecanites* is here attached to the latter family.

Gyrolecanites, which also has a goniatitic suture-line, differs considerably in the proportions of its lobes and saddles.

2. Sub-family KYMATITINÆ, Waagen.

1895, p. 207.

DIAGNOSIS. Gyronitidæ with increasing involution and sub-goniatitic suture-lines, being discoidal developments of Gyronitinae.

REMARKS. This family is here accepted in Waagen's original sense, to include the two genera *Kymatites* and *Parakymatites*, Waagen. The Dalmatian "*Kymatites*" *svilajanus*, Kittl (1903, p. 69, pl. iv, fig. 3) believed to be a homœomorphous development of the Arctoceratinæ, and is here separated as *Pseudokymatites* gen. nov. (p. 265).

The sub-family is not represented in the Collection.

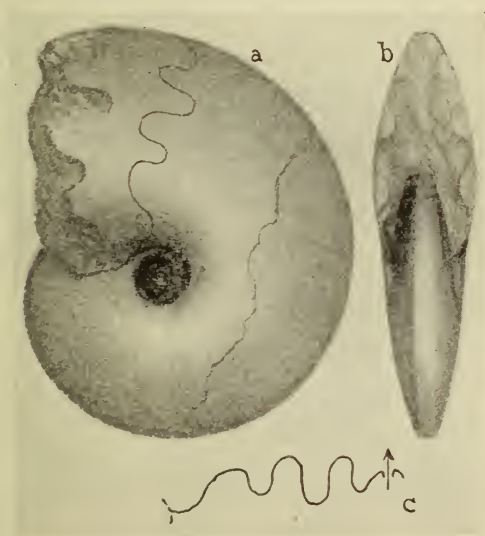


FIG. 25.—*Kymatites typus*, Waagen. Lower Eo-trias. Salt Range.
(After Waagen, 1895, pl. xxvii, figs. 1a-c.)

Genus KYMATITES, Waagen.

1895, p. 210 ; Diener, 1915, p. 181.

GENOTYPE. *Kymatites typus*, Waagen, 1895, pl. xxvii, figs. 1a-c.

DIAGNOSIS. Kymatitinæ with compressed, discoidal shells, with smooth, flattened sides, tabulate periphery and small umbilicus. Suture-line as in Gyronitidæ, but simpler.

DISTRIBUTION. Upper Gyronitan, Ceratite Marls. Salt Range.

REMARKS. It seems possible that Waagen's *Meekoceras* (*Ambites* ?) *radiosum* (1895, p. 257, pl. xxxvi, figs. 2a-d) may represent a well-preserved example of the same group.

Genus **PARAKYMATITES**, Waagen.

1895, p. 213 ; Diener, 1915, p. 216.

GENOTYPE. *Parakymatites discoides*, Waagen, 1895, p. 214, pl. xxxvi, fig. 3.

DIAGNOSIS. *Kymatitinæ* resembling *Kymatites*, but still more discoidal, involute, and with suture-line having a very wide external lobe and two distinct auxiliary saddles.

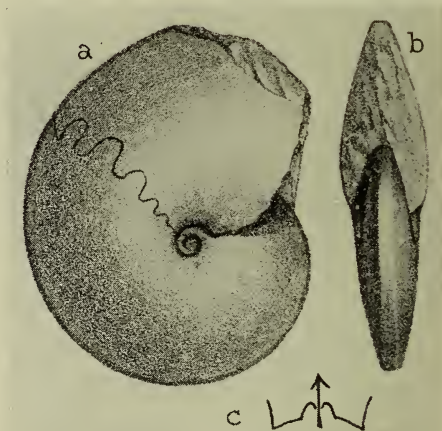


FIG. 26.—*Parakymatites discoides*, Waagen. Eo-trias ("Stachella Beds"). Chideru, Salt Range. (After Waagen, 1895, pl. xxxvi, figs. 3a-c.)

DISTRIBUTION. Flemingitan, Ceratite Sandstone. Salt Range.

REMARKS. *Parakymatites discoides*, like *Ambites*, and perhaps *Kymatites*, may owe its goniatic suture-line to corrosion or weathering; but, even if toothing of the lobe-bases should be found to occur in well-preserved examples, separation of the present genus from such similar forms as "*Meekoceras*" (*Ambites* ?) *radiosum*, Waagen (1895, p. 257, pl. xxxvi, figs. 2a-d), would still be advisable. The inclusion of *Kymatitinæ* in the family Gyronitidæ would then be confirmed, but they might perhaps also have been included in Paranoritidæ.

B. Family FLEMINGITIDÆ, Hyatt, emend.

1900, in Zittel's Text-Book of Palæontology, 1st Engl. ed., vol. i, p. 556.

DIAGNOSIS. Evolute, discoidal ammonites, generally with robust ornamentation; suture-line tending to greater elaboration than in ancestral Ophiceratidæ.

REMARKS. Hyatt included in this family, by him considered to be a "provisional group" of the "Lecanitida", *Xenodiscus* and *Xenaspis* as well as *Wyomingites*. The genus *Xenodiscus*, in the generally accepted interpretation, has already been stated to include a number of heterochronous homœomorphs, and the group described below as *Xenodiscoides*, Spath (for *Xenodiscus perplicatus*, Frech and Noetling), is one of them, here taken to be closely connected with *Flemingites* by such transitional forms as *F. rotula*, Waagen (1895, p. 195, pl. xi, fig. 3).

It is in fact difficult to distinguish small-sized specimens of *Xenodiscoides* and *Flemingites*, and it is probable that these genera are both descendants of the somewhat similar Ophiceratids, although costation is often acquired independently.

The group separated as *Pseudoflemingites* (for *Ophiceras nopcsanum*, Welter, 1922, p. 104, pl. clviii, figs. 4, 5, only; = *P. timorensis*, Spath, 1930, p. 90) and its involute development *Subflemingites* are probably closer than are the specialized *Flemingites* itself, and its coarsely strigate offshoot *Euflemingites*, to the persisting evolute and smooth Ophiceratid radical. This gave rise also to *Dieneroceras*, included here on account of its strigation, but showing a suture-line simpler than that of typical Flemingitids, and therefore transitional to "*Flemingites*" ? *russelli*, Hyatt and Smith and the Arctoceratidæ on the one hand, and to *Wyomingites* and the Meekoceratids on the other.

Subvishnuites, Spath (for *S. welteri*, Spath = *Vishnuites* sp. Welter, 1922, p. 137, pl. clxiii, figs. 3-5), is only provisionally included here as a probable keeled or, at least, fastigate development of *Pseudoflemingites*.

Genus FLEMINGITES, Waagen, 1892, p. 380.

GENOTYPE. *Ceratites flemingianus*, de Koninck, 1863, p. 10, pl. vii, fig. 1.

DIAGNOSIS. Evolute, discoidal Flemingitidæ with pronounced costation and generally also strigation. Venter rounded to

subtruncate; suture-line ceratitic to subceratitic, more advanced than in ancestral Gyronitidæ.

DISTRIBUTION. Flemingitan and Lower Owenitan (= Meekoceratan). India, Timor, Idaho.

REMARKS. Waagen thought it not at all impossible that *Gastrioceras* might be the ancestor of *Flemingites*, and he included in this genus even Hauer's Bosnian *Proteites*. This view is now discredited, although Diener (in v. Krafft and Diener, 1909, p. 107) agreed with Prof. J. Perrin Smith (in Hyatt and Smith, 1905, p. 120) in considering the true systematic position of *Flemingites* to be still uncertain. The form figured by Diener (1897, p. 98, pl. i, fig. 7) as *Flemingites guyerdeti* may be referable to *Euflemingites*, nov., discussed below, or if really from the Otoceras Beds may be merely an *Ophiceras*, without trace of radial ornamentation. On the other hand, we may with Frech (1902, p. 134) consider *Flemingites prænuntius*, Frech, to be an early form of the present genus. The typical *Flemingites* which grew to gigantic dimensions are found chiefly in the Salt Range, Himalayas, and Timor (where they range up into the Lower Meekoceratan), but the forms from Idaho (and very doubtfully from Madagascar) are only provisionally included in this genus.

It is possible that *Catalecanites*, already discussed (p. 103), represents a reduced development of the *timorensis*-group of *Flemingites*, with Gyronitan aspect.

***Flemingites flemingianus* (de Koninck), Waagen.**

1895, p. 199, pls. xii, xiii (lectotype), xiv; Diener, 1915, p. 133.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Flemingites*. Whorl-section elliptical, slightly compressed, venter arched, umbilical slope rounded. Blunt, coarse, radial ribs, tending to decline on body-chamber; strigation on outer whorls. Suture-line (fig. 27a) subceratitic, with external saddles sometimes slightly narrowed at base (monophyllitic).

MEASUREMENTS :

Waagen's example	I	.	253	.	·30	.	·25	.	·44
„	„	II	.	188	.	·33	.	·25	·41

REMARKS. The only example in the collection is crushed, and in its subtabulate periphery resembles the species next described and *Flemingites griesbachiformis*, Welter. Since this tabulation, however, may be due to deformation, and since the specimen

shows the coarser ribbing of de Koninck's species, as interpreted by Waagen, it seems permissible to refer it to this species, as was done by Prof. Koken (on the label). The example figured by Frech (1905, pl. xxvi, figs. 1*a*, *b*), the suture-line of which is here reproduced (fig. 27*a*), is also closely comparable in side-view.

HORIZON AND LOCALITIES. Flemingitan, Upper Ceratite Sandstone. Salt Range.

SPECIMENS :

C. 10455. Virgal, Salt Range.

Koken Coll., purchased 1905.

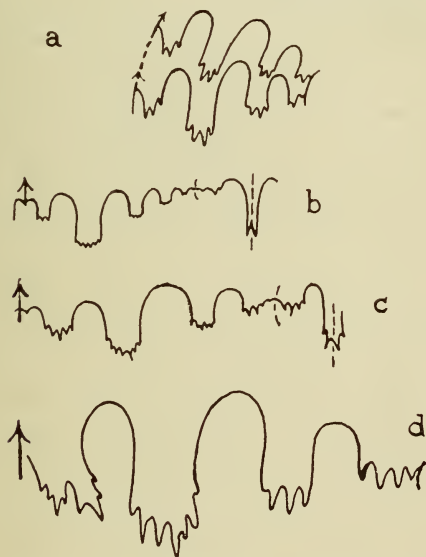


FIG. 27.—Suture-lines of *Flemingites*. Lower Eo-trias. Salt Range. *a*, *F. flemingianus* (de Koninck). After Frech, 1905, pl. xxvi, fig. 1*a*, reduced to $\frac{1}{3}$ linear. *b*, *F. prænuntius*, Frech (transitional to ancestral Gyronitidæ). After Frech, 1902, p. 135, text-fig. 3*c*. *c*, *F. glaber*, Waagen. After Waagen, 1895, pl. xi, fig. 2*d*. *d*, *F. compressus*, Waagen. *Ibid.*, pl. xvi, fig. 1*c*.

***Flemingites compressus*, Waagen.**

1895, p. 202, pl. xv, fig. 1 ; pl. xvi, fig. 1 (holotype) ; Diener, 1915, p. 133 ; Kutassy, 1933, p. 513.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Flemingites*. Whorl-section compressed elliptical, venter arched, umbilical slope gentle ; blunt, distant folds on inner

whorls, tending to irregular and closer ribbing on body-chambers. Strigation on outer whorls. Suture-line (fig. 27*d*, p. 109), subceratitic, as in *F. flemingianus*.

MEASUREMENTS :

Waagen's type	222	. . . . .	34	. . . . .	20	. . . . .	40
C. 10456	222	. . . . .	33	. . . . .	20	. . . . .	43

REMARKS. Apart from its lateral compression, this species scarcely differs from *F. flemingianus*, the genotype; Waagen stated in the text that there was absence of radial ribbing, but his figure does not differ essentially from that of *F. flemingianus* of the preceding plate (pl. xiv). The only example in the Collection that can be provisionally assigned to this species is of exactly the same size as Waagen's type, and since it is septate almost to the end, it must originally have reached about 300 mm. in diameter. Throughout the outer whorl, however, which is intermediate in section between the two species cited, and more inflated near the umbilical edge than in *F. compressus*, the venter is distinctly tabulate, and it is possible, therefore, that the example here discussed represents merely the adult stage of one of the other species of *Flemingites*. The inner whorls, unfortunately, are not sufficiently well shown for comparison with the examples described below as *Flemingites glaber* and *F. radiatus*, Waagen.

Flemingites griesbachiformis, Welter (1922, p. 113, pl. clxii, figs. 1, 2), is apparently a closely related species, and has a similar, though more compressed, whorl-section. Its ribbing, however, is rather coarser and slightly rursiradiate on the first part of the last half-whorl, and degenerates suddenly into indistinct striation. The suture-line again is almost identical in the two species.

HORIZON AND LOCALITIES. Flemingitan (Upper Ceratite Sandstone). Salt Range.

SPECIMENS :

C. 10456. Virgal, Salt Range. *Koken Coll., purchased 1905.*

***Flemingites glaber*, Waagen.**

1895, p. 188, pl. xi, figs. 2*a-d* (holotype); Diener, 1915*a*, p. 133.

DIAGNOSIS. Substenogyral, leptogyral, subangustumbilicate *Flemingites*. Whorl-section compressed with flattened sides; fine strigation, especially near subtabulate periphery. Suture-line ceratitic, with comparatively short saddles (fig. 27*c*, p. 109).

MEASUREMENTS :

Waagen's holotype	. 80	. .35	. .19	. .40
C. 10420a	. 102	. .35	. ?	. .39

REMARKS. The only example in the Koken Collection that was referred to Waagen's species is crushed, and the inner whorls are corroded, so that exact identification is impossible. In *F. radiatus*, Waagen, however, which has merely a slightly smaller umbilicus and greater whorl-height, the radial ribs are rather coarse and blunt. The difference in whorl-section, and especially in periphery, is very striking in Waagen's figures; but since the examples are generally imperfectly preserved or crushed, not nearly so obvious in the actual specimens. There is scarcely any radial ornamentation in the example here described, and the sides are perfectly flat. The ammonite, moreover, is still completely septate at 100 mm. diameter, and it is possible, therefore, that it represents merely the inner whorls of one of the larger species of the group of *F. flemingianus*.

HORIZON AND LOCALITIES. Flemingitan (Ceratite Sandstone). Salt Range.

SPECIMENS :

C. 10420a. Virgal, Salt Range. *Koken Coll., purchased 1905.*

Flemingites radiatus, Waagen.

1895, p. 197, pl. xi, fig. 1a, b (holotype); Diener, 1915a, p. 133.

DIAGNOSIS. Subplatygyral, subleptogyral to leptogyral, sublatumbilicate *Flemingites*. Sides flattened, venter arched to subtabulate. Blunt and distant radial ribs; fine strigation. Suture-line ceratitic, as in *F. glaber*.

MEASUREMENTS :

Waagen's holotype	. 83	. .39	. .18	. .35
Waagen's paratype	. 72	. .40	. .17	. .36
B.M., C. 10422	. 77	. .40	. ?	. .35

REMARKS. Of the two examples in the Collection that seem referable to the present species, one is crushed, and the other (originally identified by Prof. Koken with *Flemingites glaber*) is corroded, so that it might be held that they are merely immature examples of some of the typical and large species of *Flemingites* of the *flemingianus* group. The suture-line of the example listed above (C. 10422), like that of *F. glaber* (Waagen's pl. xi, fig. 2d), has a distinct auxiliary lobe, a feature distinguishing it from the similar *F. rotula*, Waagen.

HORIZON AND LOCALITIES. Flemingitan, Ceratite Sandstone. Salt Range.

SPECIMENS :

C. 10422. Virgal, Salt Range. *Koken Coll., purchased 1905.*

C. 10420b. *Ibid.* (originally labelled "*Flemingites glaber*").

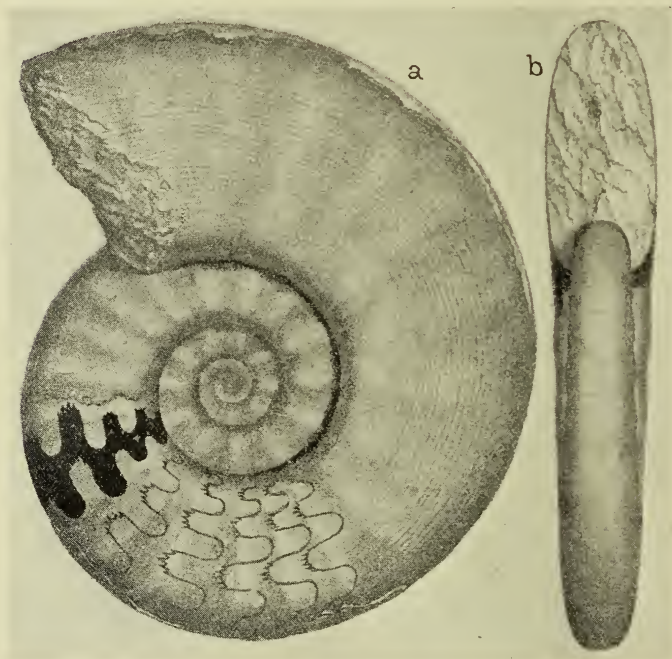


FIG. 28.—*Flemingites radiatus*, Waagen. Lower Eo-trias, Ceratite Sandstone. Salt Range. . (After Waagen, 1895, pl. xi, figs. 1a, b.)

***Flemingites* (?) *russelli* (Hyatt and Smith MS.) Smith.**

Fig. 86c, p. 253.

1904, p. 378, pl. xlii, fig. 5 (holotype) ; pl. xliii, figs. 5, 6 ; Hyatt and Smith, 1905, p. 121, pl. i, figs. 1-3 ; pl. lxx, figs. 1-3 ; Diener, 1915a, p. 133.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Flemingites* ?. Whorl-section compressed, venter subtabulate, rounded, with faint striation and later, radial folds ; strigation not pronounced. Suture-line (fig. 86c, p. 253) resembling that of *F. glaber* (fig. 27c, p. 109), but more simplified.

MEASUREMENTS :

Hyatt and Smith (1905, p. 121)	. 104	.36	.20	.31
C. 21854a	. . . . . 50	.44	.24	.29
C. 21854b	. . . . . 93	.39	.21	.31

REMARKS. A large example of the present species in Dr. Trechmann's collection shows, at a diameter of over 110 mm., half a whorl of body-chamber. The umbilicus does not widen appreciably, and the obvious difference in aspect from the typical *Flemingites* of the Salt Range is as pronounced in the adult as it is in the young. The Timor *Flemingites densistriatus*, Welter (1922, p. 116, pl. clx, figs. 5-7), shows somewhat similar coiling, but is more evolute, more compressed peripherally, and has a more highly developed suture-line. The presence of an " *Aspidites* "-like auxiliary series in *Subflemingites* (discussed below) prevents the reference of the American species to this genus, but in whorl-shape and general appearance *S. meridianus*, Welter (1922, p. 132, pl. clxvi, figs. 1-3), closely resembles the form here discussed.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan. Idaho, U.S.A.

SPECIMENS :

C. 21854a, b. Aspen Mts., near Bear Lake, S.E. Idaho.

Dr. C. T. Trechmann (ex J. Perrin Smith) Coll.

***Flemingites timorensis*, Wanner.**

1911, p. 187, pl. vii, figs. 1, 2 ; Welter, 1922, p. 115 ; Kutassy, 1933, p. 514.

DIAGNOSIS. *Flemingites* like *F. radiatus*, but with folds less close in young and more approximate in adult ; also a sharply truncate periphery.

MEASUREMENTS :

Wanner (holotype)	. 87	. .34	. .19	. .39
Wanner (p. 187)	. 66	. .36	. .18	. .39

REMARKS. Some of the examples in the Collection (C. 33974-5) are more inflated, and may thus correspond to what Welter (1922, p. 113, pl. clx, figs. 8, 9) doubtfully included in v. Krafft's *F. muthensis* (in v. Krafft and Diener, 1909, p. 108, pl. xxii, fig. 2). The thickness amounts to 22-25% in this species, but specific separation, both of the more inflated Timor examples and of the more evolute varieties (C. 33977, 33981) seems

impossible. In the associated *Prionolobus wanneri* there is equally great variability in the width of the truncate periphery and of the umbilicus; and some doubtful, intermediate forms are referred to the present species merely on the basis of the longitudinal striation, which, however, may be confined to the ventral area. Three immature examples (C. 33976, C. 34003-4) may perhaps be the young of a form like *F. densistriatus*, Welter (1922, p. 116, pl. clx, figs. 5, 6).

HORIZON AND LOCALITIES. Lower Eo-trias, Flemingitan. Timor.

SPECIMENS :

C. 33970-75. Nifoekoko, Timor. *M. E. Walsh Coll.*, 1930.

C. 33977-8, 33980-34002, 33976 ?, 34003-4 ? Toeboelopo, Timor. *M. E. Walsh Coll.*, 1930.

C. 34045-6, 34076-7, 37318 ?, doubtful, young examples.

Same Coll.

Flemingites (?) lidacensis, Welter.

1922, p. 115, pl. clxi, fig. 1 only; Kutassy, 1933, p. 514.

DIAGNOSIS. *Flemingites* ? like *F. radiatus*, but with folds of inner whorls still more strongly marked, as in *Xenodiscoides*, and with strigation much less distinct. Suture-line with longer saddles than in *F. radiatus*.

MEASUREMENTS :

Welter (p. 116, no. 1)	159	.	·35	.	·19	.	·41
C. 33969	145	.	·32	.	·18	.	·43

REMARKS. The example here referred to Welter's species differs from the type in being slightly more evolute and, perhaps, in having the spiral striation still less distinctly marked. It might thus well have been included in *Xenodiscoides*, and is probably a transitional species to that genus. But in provisionally referring this form to *Flemingites*, the writer is influenced by Welter's including in his species a smaller example (figs. 3, 4), which seems to be a more typical *Flemingites*, and is much less coarsely ornamented than the specimen here listed.

HORIZON AND LOCALITIES. Lower Eo-trias, Flemingitan. Timor.

SPECIMENS :

C. 33969. Toeboelopo, Timor.

M. E. Walsh Coll., 1930.

Genus **EUFLEMINGITES**, nov.

GENOTYPE. *Flemingites guyerdetiformis*, Welter, 1922, p. 117, pl. clx, figs. 10-12.

DIAGNOSIS. Flemingitidæ with more-or-less involute serpen-ticone shells with slightly compressed whorls and arched periphery, rounded umbilical wall and distinct strigation, but no radial ornamentation. Suture-line as in other Flemingitids, with rather shallow external lobe.

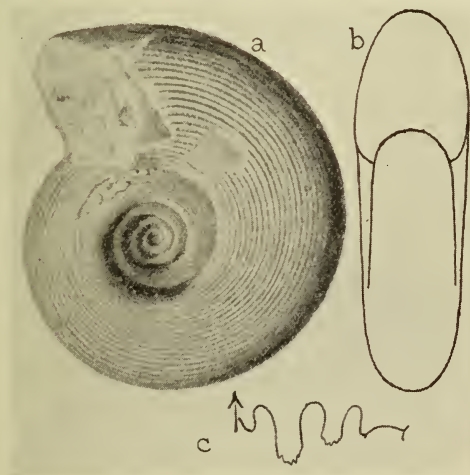


FIG. 29.—*Euflemingites guyerdetiformis* (Welter). Eo-trias, Owenitan ?. Timor. (After Welter, 1922, pl. clx, figs. 10-12.)

DISTRIBUTION. Upper Eo-trias, Owenitan ? Timor ; Hima-layas ; Spitsbergen ?.

REMARKS. This stock is distinguished from the true *Flemingites* by its unusually strong strigation more than by its suture-line or its smooth serpen-ticone inner whorls. *Euflemingites* shows greater resemblance to *Pseudoflemingites* and to *Subflemingites*, both occurring in the same beds ; but there are important differences in suture-lines and other charactèrs, as is evident from Welter's reference of the former to *Ophiceras*, and of the latter to '*Aspidites*.' The genus *Dieneroceras*, described below, differs in suture-line ; *Xenodiscoides* is distinguished from the present genus by its coarse radial ornamentation. Welter's *Flemingites densistriatus*, already referred to (p. 114),

resembles *Euflemingites* in its serpentine inner whorls, but probably represents an involute development of *Pseudoflemingites*, transitional to *Subflemingites*, with radial ornamentation of *Flemingites*, but different inner whorls.

The Himalayan *Euflemingites guyerdeti*, Diener sp. (1897, p. 98, pl. i, figs. 7a-c), was said to come from the *Otoceras* Beds, but it is probably of Upper Eo-triassic age, like the associated *Juvenites*. Since *E. cirratus* (White), J. P. Smith sp. (1932, p. 53, pl. xx, fig. 1; pl. xxvi, figs. 1-12), also has an outer whorl resembling that doubtful Spitsbergen impression (B.M., C. 27213) I recorded in 1921 (p. 300), it is probable that *Euflemingites* is of later age than the true *Flemingites*.

Genus PSEUDOFLEMINGITES, Spath.

1930, p. 90.

GENOTYPE. *P. timorensis*, Spath = *Ophiceras nopcsanum*, Welter, *partim*, 1922, p. 104, pl. clviii, figs. 4, 5 only, *non* figs. 1-3.

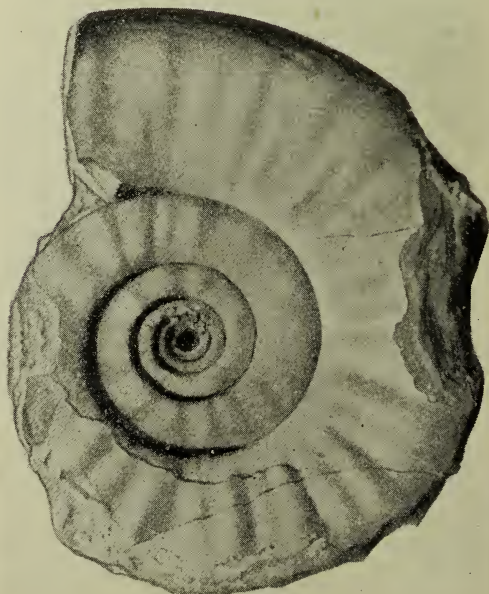


FIG. 30.—*Pseudoflemingites timorensis*, Spath (= "*Ophiceras nopcsanum*" Welter *partim*). Upper Eo-trias, Owenitan. Timor. (After Welter, 1922, pl. clviii, fig. 4.)

DIAGNOSIS. Flemingitids with serpenticone, discoidal shells, with costation as in *Xenodiscoides*, or strigation as in megalomorph *Flemingites*, but with very evolute, smooth, inner whorls, and simpler suture-lines.

DISTRIBUTION. Upper Eo-trias, Owenitan (= Meekoceratan). Timor.

REMARKS. This genus is connected with *Flemingites* by such forms as *P. rotuliformis*, nom. nov. (= *Xenodiscus rotula*, Welter, 1922, p. 106, pl. clx, figs. 3, 4, non Waagen), whilst *P. molengraaffi* (Welter, 1922, p. 108, pl. clviii, figs. 10-13) seems to be transitional to *Xenodiscoides*. On the other hand, the genera *Kashmirites*, *Preflorianites* (compare especially "*Xenodiscus*" *bittneri*, Welter, 1922, p. 106, pl. clviii, figs. 8, 9, non Hyatt and Smith), and *Xenoceltites* (see p. 127), discussed below and referred to different families, may also have sprung from the same stock, persisting in the primitive *Dieneroceras*. Though later in date than the early *Flemingites prænuntius*, Frech, and even the later specialized large *Flemingites* of the *flemingianus* group, *Pseudoflemingites* retained the ancestral evolute inner whorls.

Genus SUBVISHNUITES, Spath.

1930, pp. 30, 90.

GENOTYPE. *S. welteri*, Spath = *Vishnuites* sp., Welter, 1922, p. 137, pl. clxvii, figs. 3-5.

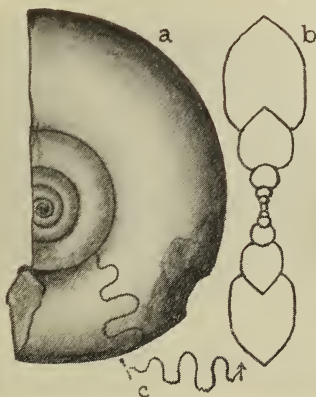


FIG. 31.—*Subvishnuites welteri*, Spath (= "*Vishnuites*" sp., Welter, 1922, pl. clxvii, figs. 3-5). Upper Eo-trias, Owenitan. Timor. (After Welter.)

DIAGNOSIS. Flemingitidæ with evolute, discoidal, smooth shells, like the inner whorls of *Pseudoflemingites* and with a similar Flemingitid suture-line, but with a tendency of the periphery to become fastigate.

DISTRIBUTION. Upper Eo-trias, Owenitan (= Meekoceratan). Timor.

REMARKS. It has already been mentioned that the form on which the present genus is based has no affinity with the much earlier *Vishnuites*, characterized by its gyronitid suture-line and its general *Ophiceras* aspect. At least Diener's Kashmir example (1913, p. 21, pl. iii, fig. 4), if not the Shalshal fragment (1897, p. 88, pl. vii, figs. 4, 5), as Diener correctly remarked, differs from *Ophiceras* merely in its acute siphonal edge. So do the many East Greenland examples now before me. The reference of *Subvishnuites* to the family Flemingitidæ, on the other hand, based on its late age and resemblance to *Pseudoflemingites*, is provisional, pending the discovery of derivatives of *Subvishnuites*. It certainly is impossible to connect it with Inyoitidæ, which are much closer to *Preflorianites*; with Owenitidæ, apparently modified Paranannitidæ; or with the Hungaritidæ, keeled offshoots of another Meekoceratid (?) stock.

Genus SUBFLEMINGITES, nov.

GENOTYPE. *S. involutus*, nom. nov. (= "*Aspidites*" *meridianus involutus*, Welter, 1922, p. 134, pl. clxvi, figs. 4, 5.)

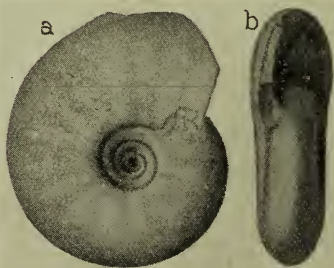


FIG. 32.—*Subflemingites involutus*, nom. nov. (= "*Aspidites*" *meridianus involutus*, Welter). Upper Eo-trias, Owenitan ?
Timor. (After Welter, 1922, pl. clxvi, figs. 4, 5.)

DIAGNOSIS. Flemingitidæ having involute, subdiscoidal shells, with smooth serpenticone inner whorls, rounded umbilical wall

and arched periphery. Suture-line with irregular auxiliaries, as in *Clypeoceras*.

DISTRIBUTION. Upper Eo-trias, Owenitan ?. Timor.

REMARKS. This genus probably represents an involute development of *Pseudoflemingites*, and shows a similar tendency to blunt, distant ribbing on the outer whorls, characteristic of Flemingitids, but not observed in true *Clypeoceras*, which also has more involute inner whorls with truncate or sharpened periphery. "*Flemingites*" *densistriatus*, Welter, already referred to (pp. 114 and 116), is transitional between *Pseudoflemingites* and *Subflemingites*, but in suture-line shows greater resemblance to the former genus. *Euflemingites* is distinguished by its strigation as well as by its suture-line. In these three genera, however, the inner whorls are similar, whereas in true *Flemingites* and *Xenodiscoides* these are less loosely coiled, but bluntly ribbed.

Genus **XENODISCOIDES**, Spath.

1930, pp. 12, 90.

GENOTYPE. *Xenodiscus perplicatus*, Frech, 1905, pl. xxii, fig. 4, as represented by B.M., C. 10425.

DIAGNOSIS. Flemingitids with discoidal, strongly ribbed shells with rounded or subtabulate venters, resembling the inner whorls of *Flemingites*, but without strigation. Suture-line ceratitic, slightly simpler than in *Flemingites*, with entire (lituid) internal lobe.

DISTRIBUTION. Lower Eo-trias, Flemingitan, Middle and Upper Ceratite Marls. Salt Range.

REMARKS. It has already been mentioned (p. 82) that the *Xenodiscus*-like forms of Noetling and Frech's zone of "*Celtites*" *radiosus* cannot be included in *Glyptopliceras* (of the Otoceratan age), and probably do not belong to the "Xenodiscids" now under discussion, of the Gyronitan and Lower Flemingitan (and which occur especially in Noetling and Frech's zones of "*Celtites*" *fallax* and "*Prionolobus*" *volutus*). They seem comparable merely because they are both ribbed, although the suture-lines figured by Frech (1905) in the explanation to his plate xxii show that in "*Celtites*" *radiosus* and "*C.*" *fortis*, Koken (doubtfully referred to *Anakashmirites*), the external saddles as well as the auxiliaries are somewhat different from those of the forms belonging to the higher zone. In any case only the *perplicatus* group is here comprised in *Xenodiscoides*.

The Albanian "*Xenodiscus*" *sulioticus*, Arthaber (1911, p. 229, pl. xix, fig. 6, pl. xx, fig. 2), again has an entirely different suture-line, and in ornamentation also is much closer to certain Anisian Danubitids and Celtitids (*Tropigastrites*) and to *Preflorianites*, referred to below, than to the group here discussed.

The doubtful form described below as *X. ? hollandi*, sp. nov., is unlike any ammonite previously recorded, and on account of its sharpened venter, has a distant resemblance to the Ophiceratid genera *Vishnuites*, *Subinyoites*, and certain evolute Paranoritids or Gyronitids (e. g. *Prionolobus*). In the first two, however, the periphery is more acute, and there are other important differences, but the ribbed forms of *Prionolobus* are again close to *Xenodiscoides*. Since there is only a single imperfect example of *X. ? hollandi* available for study, it may be provisionally included in the genus *Xenodiscoides*. Its probable ally, "*Meekoceras*" *falcatum*, Waagen (1895, p. 242, pl. xxxvi, figs. 4a-c), has been compared by Diener (1913, p. 5) to *Glyptophiceras himalayanum* (Griesbach), an earlier homœomorphous development, but appears to be similarly transitional between the persisting radical and *Xenodiscoides*.

Xenodiscoides perplicatus (Frech).

Xenodiscus perplicatus, Frech, 1905a, pl. xxii, fig. 4; Diener, 1915a, p. 314.

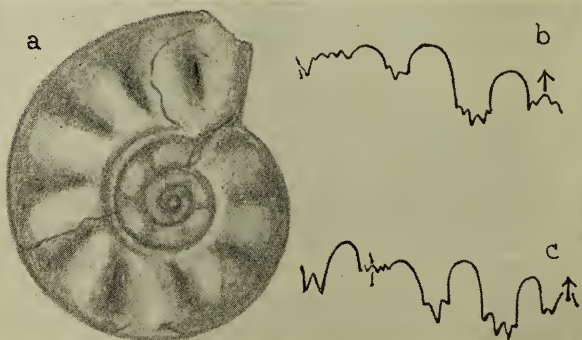


FIG. 33.—a, c, *Xenodiscoides perplicatus* (Frech). Lower Eo-trias, Flemingitan. Salt Range. (After Frech, 1905, pl. xxii, fig. 4 and suture-line, $\times 2$.) b, *X. involutus* (Frech). *Ibid.*, fig. 3a ($\times 2$). (= "*Xenodiscus perplicatus*, var. *involuta*", Frech.)

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Xenodiscoides*. Whorl-section compressed, with gently convex sides and tabulate periphery; blunt, coarse, slightly rursiradiate ribs, about 10-12 to the whorl, getting closer towards aperture. Suture-line ceratitic (see fig. 33c, p. 119).

REMARKS. This characteristic species is represented by five examples, of which three were labelled "*Xenodiscus indicus*, Koken", and another "*Xenodiscus volutus*, Koken". They are distinguished by their much coarser ribbing from the form described below as *Xenodiscoides involutus* (Frech = *Xenodiscus perplicatus*, var. *involuta*, Frech), whilst "*Celtites fallax* (Koken MS), Frech, which may belong to *Anakashmirites* rather than to the present genus, is not only more closely costate, but also more evolute, and has a simpler suture-line.

Flemingites muthensis, v. Krafft (in v. Krafft and Diener, 1909, p. 108, pl. xxii, figs. 2a-c), with more advanced suture-line, is superficially similar to the species here discussed, also the Timor example doubtfully referred by Welter (1922, p. 113, pl. clx, figs. 8, 9) to v. Krafft's form. In both, however, the ornamentation is anagenetic. On the other hand, "*Xenodiscus nivalis* (Diener), as represented by the Himalayan example figured in 1909 (in v. Krafft and Diener, p. 102, pl. xxv, figs. 5a, b = *Anakashmirites*, Spath), although coarsely plicated on the inner whorls, is transitional to *Kashmirites* and leads to a different stock.

HORIZON AND LOCALITIES. Flemingitan, Ceratite Marls (zone of "*Prionolobus volutus*). Salt Range.

SPECIMENS :

- C. 10425. Virgal, Salt Range. *Koken Coll., purchased 1905.*
 C. 10430. *Ibid.* (Labelled "*Xenodiscus volutus*, Koken.")
 C. 10451. *Ibid.* (Labelled "*Xenodiscus indicus*, Koken.")
 C. 10413 ? *Ibid.* (Labelled "*Xenodiscus indicus*, Koken.")
 C. 10418 ? *Ibid.* (Labelled "*Xenodiscus indicus*, Koken,
Celtites Bed.")

. *Xenodiscoides involutus* (Frech).

Xenodiscus perplicatus, var. *involuta*, Frech, 1905, pl. xxii, fig. 3 ;
 Diener, 1915, p. 314.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Xenodiscoides*. Whorl-section compressed, periphery tabulate. Ribbing comparatively blunt and coarse on inner whorls only, finer and indistinct on outer whorl. Suture-line as in last species (fig. 33b, p. 119).

REMARKS. Frech considered the present form to be merely a variety of *X. perplicatus*, but the differences—notably greater compression and involution, and finer ornamentation—are more important than those between many other allied species of ammonites. *X. radians* (*non* Waagen ?) in v. Krafft and Diener (1909, pl. xxv, figs. 1–3) and *X. cf. plicatus*, *non* Waagen ? (*ibid.*, fig. 4), are more evolute than the form here described, but probably belong to the same group.

"*Celtites fallax* (Koken MS), Frech (1905, pl. xxii, fig. 5), referred by Diener (1915*a*, p. 312) to *Xenodiscus*, is more evolute than the species here discussed. The doubtful Kashmir example, figured by Diener (1913, pl. iv, fig. 4) as *Flemingites* (?) sp. ind. aff. *muthensis* (v. Krafft), somewhat resembles the present species in whorl-shape, but the inner whorls are different, and the ornamentation of the outer whorl of the Kashmir ammonite remains coarse and comparatively distant.

HORIZON AND LOCALITIES. Flemingitan, Ceratite Marls ("Celtites Bed"). Salt Range.

SPECIMENS :

C. 10446. Virgal, Salt Range. Koken Coll., purchased 1905 (labelled "*Xenodiscus æqualis*, Koken").

Xenodiscoides ? hollandi, sp. nov.

Plate III, figs. 3*a*, *b*.

TYPE. B.M., C. 10414, *ex* Koken Coll. ("*Xenodiscus hydaspis*", Koken MS. p.p.).

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Xenodiscoides*. Whorl-section compressed, with narrowly arched, almost acute, periphery and rounded umbilical edge. Inner whorls with indistinct, coarse, rectiradiate folds, degenerating on outer whorl. Suture-line with denticulated auxiliaries, as in *Paranorites*.

MEASUREMENTS :

Holotype (Pl. III, figs. 3*a*, *b*) . 130 .34 .18 .43

REMARKS. This form, as already mentioned, is included in *Xenodiscoides* with some doubt, chiefly on account of its defective preservation. It is possible that it represents a new genus, allied to *Paranorites*, or even to *Pseudoflemingites*, with a tendency to sharpen the periphery, but with comparatively strong costation. The resemblance to the present genus, due to its ribbing, may thus be quite accidental. On the other

hand, Waagen's "*Meekoceras*" *falcatum* (1895, p. 242, pl. xxxvi, fig. 4), although said to occur in a higher bed than the holotype of the species here discussed, appears to be a closely allied form. It differs chiefly in a less acutely arched periphery, smaller umbilicus, with steeper edge, and less straight ribbing. Such Flemingitids as show a comparable tendency to sharpening of the periphery, for example, the Timor "*Flemingites*" *densistriatus*, Welter (1922, p. 116, pl. clx, figs. 5-7), have a slightly more advanced suture-line. The more typical species of *Pseudoflemingites* are distinguished by their far more evolute inner whorls.

The form described below as *Paranorites hydaspis* (Koken MS.), sp. nov., is close to *P. ambiensis* (Waagen), and not identical with the present form, as Koken thought.

HORIZON AND LOCALITIES. Upper Gyronitan, Lower Ceratite Marls. Salt Range.

SPECIMENS :

C. 10414. Chideru (labelled "*Xenodiscus hydaspis*, Koken. Untere Kalke, mit *Prionolobus rotundatus*").

Koken Coll., purchased 1905.

? Genus **DIENEROCERAS**, gen. nov.

GENOTYPE. *Ophiceras dieneri*, Hyatt and Smith, 1905, p. 118, pl. viii, figs. 16-29.

DIAGNOSIS. Small Flemingitids with evolute, slightly compressed shells, rounded whorl-section, and arched venter. Suture-line ceratitic, or goniatic, generally with only two lateral lobes.

DISTRIBUTION. Upper Eo-trias, Owenitan (= Meekoceratan). California.

REMARKS. Hyatt and Smith referred the genotype of the present genus to *Ophiceras* chiefly because they considered the "spiral lines" to be the distinguishing character of the genus. From its faunal association and the details of the suture-line (especially internal), *Dieneroceras* is believed to be a primitive Flemingitid, and not an Ophiceratid; and it is suggested below (p. 250) that by forms like "*Lecanites*" *knechti* (Hyatt and Smith, 1905, p. 138, pl. ix, figs. 11-16) and "*Paralecanites*" *arnoldi*, Hyatt and Smith (*ibid.*, p. 136, pl. lxiv, figs. 1-16), *Wyomingites* can be connected with the family Flemingitidæ. In the American forms of *Flemingites*

(see p. 112) the inner whorls do not show serpenticone coiling, as in *Dieneroceras*, except at a small diameter, and the comparatively wide, flattened sides have a distinct umbilical edge at an early stage (20 mm.); but the suture-line, with the second lateral saddle at that diameter still on the umbilical edge, is not unlike that of the present genus.

Subflemingites is more involute than *Dieneroceras* and has a complex suture-line that has been compared to that of

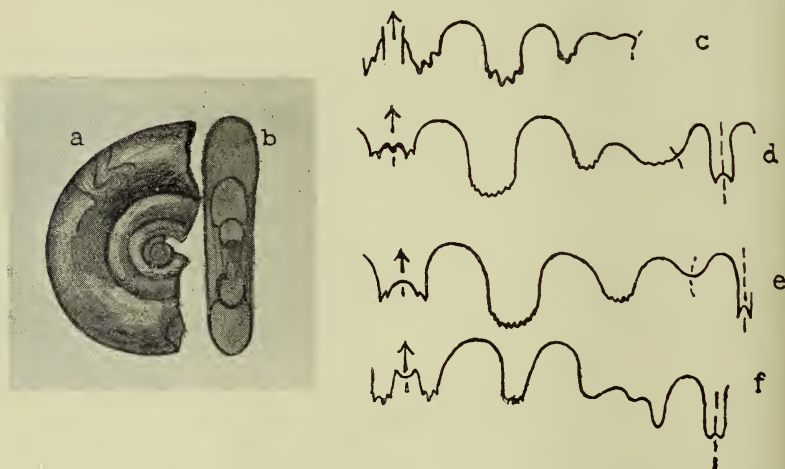


FIG. 34a, b.—*Dieneroceras dieneri* (Hyatt and Smith). Upper Eotrias, Owenitan. California. (After Hyatt and Smith, 1905, pl. viii, figs. 16, 17.) c, *Dieneroceras* sp. ind. ("*Ophiceras*" *sakuntala*, J. P. Smith, non Diener). Owenites Beds. California. (After Smith, 1932, pl. liv, fig. 5.) d, *Ophiceras* cf. *demissum* (Oppel). Otoceras Beds. East Greenland (no. 174a). e, *Glyptophiceras* sp. nov. ind. Same beds and locality (no. 1m). f, *Dieneroceras* ("*Ophiceras*") *parvum*, J. P. Smith. Owenites Beds. California. (After Smith, 1932, pl. liv, fig. 30.) Suture-lines c-f all enlarged, $\times 4$.

Clypeoceras. The inner whorls of *Pseudoflemingites*, however, are morphological equivalents of *Dieneroceras*, and can be distinguished merely by their different external lobe and the proportions of the lateral saddles and lobes.

The genus *Dieneroceras* may not, at present, seem very satisfactorily established; but it appears to me that a smooth Ophiceratoid stock, with comparatively simple suture-line (and therefore with pseudogoniatic, "lecanitid" forms), persisted long after the Ophiceratidæ disappeared, having become

specialized in various directions. It also seems to me that such a smooth, primitive stock is a more likely root of apparently cryptogenous, later, ornamented, stocks than are homœomorphous, specialized developments among earlier groups.

Figs. 34c-f represent the suture-lines of two true Ophiceratids (*Ophiceras* cf. *demissum*, Oppel sp., and *Glyptophiceras* sp. nov. ind.), together with those of two of J. P. Smith's "*Ophiceras*"



FIG. 35.—Suture-lines of *Dieneroceras dieneri* (Hyatt and Smith).
a, Adult, enlarged, $\times \frac{8}{3}$. b, Immature, $\times 8$. (After Hyatt and Smith, 1905, pl. viii, figs. 18, 24.)

("O." *sakuntala*, Smith, non Diener, and "O." *parvum*), and it will be seen that the latter are probably Flemingitids (compare J. P. Smith's pl. xxiii, fig. 26). Whether, however, all the species of this author's "*Ophiceras*" (some also described as "*Xenodiscus*") belong to *Dieneroceras*, is difficult to decide from the figures, and some may be merely the young of forms of allied Flemingitidæ.

c. Family XENOCELTITIDÆ, Spath.

1930, p. 89.

DIAGNOSIS. Evolute, discoidal ammonites; generally ribbed, especially on the inner whorls, or constricted, with costæ often projected forwards across a smooth, arched or keeled venter. Suture-lines ceratitic or entire, with generally only two lateral lobes.

REMARKS. This family is created for certain genera of the Upper Eo-trias that are believed to be derived from the same primitive "ophiceratid" or "lecanitid" stock which, by *Dieneroceras* and "*Lecanites*"-like forms, also produced the Flemingitids and the Meekoceratidæ, but which modified its primitive (*Glyptophiceras*) characters only in the ventral area. *Protophiceras*, Hyatt, discussed on p. 87 (under Ophiceratidæ), and included by Diener and Arthaber in *Xenodiscus*, is based

on a species which was originally described by Diener as closely related to *Glyptophiceras himalayanum* (Griesbach), and which was associated with another form ("*Danubites*" nov. sp. ind.), characterized as a "typical *Danubites* of the group of the *obsoleti*". Inasmuch as *Protophiceras* occurs in the Ussuri Beds with "*Ceratites*" *minutus*, Diener, non Waagen, identified with a Salt Range species, and inasmuch as the latter resembles Waagen's *Dinarites evolutus* and the Spitsbergen forms recorded by the writer (Spath, 1921, p. 302) as "gen. nov. (*Danubites*?, *Xenodiscus*?)", it might be thought that *Protophiceras* and *Xenoceltites* are synonymous. In *Xenoceltites*, however, the ribs are strongest, almost tuberculate, on the inner whorls and degenerate on the outer whorls, often to become mere constrictions, as in *Cuccoceras*; whereas in *Protophiceras* the ribbing of the inner whorls is faintly indicated, but the ornamentation becomes conspicuous only on the outer whorl, i. e. just the reverse of what is characteristic of the *Xenoceltitids*, or of *Glyptophiceras*.

"*Xenodiscus*" *bittneri*, Hyatt and Smith (1905, p. 123, pl. xx, figs. 5-15), may be a late form of *Xenoceltites*, but *Danubites strongi*, Hyatt and Smith (1905, p. 165, pl. ix, figs. 4-10), has been separated as *Preflorianites*, Spath (1930), on account of its importance as one of the radicals of the family *Celtitidæ*. It is connected with *Xenoceltites* by forms somewhat resembling *Xenodiscus bittneri* (Welter, non Hyatt and Smith, 1922, p. 106, pl. clviii, figs. 8, 9 of Owenitan age). There is a number of doubtful forms of "*Xenodiscus*" in geological literature intermediate between *Glyptophiceras* and *Xenoceltites*, and it is not often possible to place them correctly from the illustrations alone. I believe, however, that the various "*Xenodiscus*" figured by J. P. Smith in his latest work (1932) are as wrongly identified as his "*Ophiceras*", i. e. they are merely *Flemingitids* or *Meekoceratids* with a superficial resemblance to the much earlier true *Xenodiscus* and *Ophiceras*. But his *Xenodiscus rotula*, which has nothing to do with Waagen's "*Gyronites*" *rotula* or the Timor *Pseudoflemingites* figured under that name, and which is probably identical with Mathews's "*Ophiceras*" *matheri*, is apparently a *Xenoceltites*, as is the latter author's *Xenodiscus hannai*.

The resemblance of some *Xenoceltites* to *Flemingitids*, such as *Xenodiscoides* and *Pseudoflemingites*, or to *Kashmiritids*, may be explained by their common derivation from a primitive *Ophiceratid* stock. The *Inyoitinae*, also believed to be connected with *Preflorianites*, form a specialized side-branch.

Pseudodanubites, Hyatt, is here referred to Celtitidæ; it had also been compared by Hyatt and v. Krafft to *Japonites*.

The reduced *Hemilecanites* is only doubtfully included in the present family. Like the last genus, it also produced *Japonites*- and *Sibyllites*-like forms that resemble later Celtitids, but on the whole it is probably closer to the less distinctly ornamented species of *Xenoceltites*.

1. Sub-family XENOCELTITINÆ.

DIAGNOSIS. Xenoceltitids with arched or sometimes slightly sharpened venters, smooth. or crenulate when traversed by faint prolongations of lateral ribs.

Genus XENOCELTITES, Spath.

1930, pp. 12, 90.

GENOTYPE. *Xenoceltites subevolutus*, Spath = *Xenodiscus* cf. *comp-toni* (non Diener), Frebold, 1930, p. 14, pl. iii, figs. 1 (lectotype), 2, 3.

DIAGNOSIS. Compressed, discoidal, serpticone Xenoceltitidæ, with faint and distant bulges on the inner whorls and irregular costation, generally causing constrictions, on the outer. Suture-line ceratitic, with two, faintly toothed, lateral lobes (pl. vi, fig. 4).

DISTRIBUTION. Upper Eo-trias, Columbitan. Spitsbergen; Siberia? (Olenek River and Ussuri); Salt Range; Utah.

REMARKS. The numerous Spitsbergen forms in the Collection, which first showed the need for the present genus, were previously considered to belong to the same (unnamed) group as "*Dinarites*" *evolutus*, Waagen, and "*Ceratites*" *minutus* (Diener, non Waagen)—a form subsequently listed by Diener (1915a, p. 121) as "*Dinarites* (an *Cuccoceras*?)". The comparison of *D. evolutus* to *Bittnerites* (Kittl, 1903, p. 66), and therefore to Tirolititidæ, perhaps, is not inapt. Associated in the same slabs with numerous young *Xenoceltites* there occurred various immature forms with more distinct bulges or tubercles, that have been doubtfully attached to *Olenikites*; and it has already been seen that one form of the Arctic group of the "obsoleti", namely, that of *Ceratites sigmatoideus*, Mojsisovics (1886, p. 24, pl. ii, fig. 10), like the same author's *Dinarites glacialis* (*ibid.*, p. 18, pl. ii, fig. 11), cannot be separated from the typical *Olenikites*, in spite of slightly less reduced

lobes. It has already been mentioned that the Dinaritidæ and Tirolitidæ are probably (suturally simplified) derivatives of the persisting "Ophiceratid" root-stock, and their convergence towards the members of the family here discussed is to be expected.

The writer previously stated that the Spitsbergen forms greatly resembled certain "*Xenodiscus*", e. g. *X. cf. lissarensis*, Diener (1913, p. 5, pl. i, fig. 11), and *X. comptoni*, Diener (*ibid.*, p. 10, pl. ii, fig. 7), but were probably more nearly related to "*Danubites*", e. g. "*D. hyperboreus* (Mojsisovics). Comparison with the young of late *Glyptophiceras* shows that their bulges or subtuberculate folds are very similar to those of the early stages of *Xenoceltites*, but in early *Glyptophiceras* they are of a different (straight) type, and the resemblance to the early true *Xenodiscus* is similarly superficial. The "obsoleti", on the other hand, even if perhaps separable as a sub-genus (since they are of different date and do not show constrictions), clearly belong to the same stock. They are based on immature and insufficient material, and among the hundred examples of the species described below, rivalling in variability Welter's Timor *Anasibirites multiformis*, there are individuals that, if found by themselves, might easily have been referred to some species of the "obsoleti", especially the smooth "*Ceratites discretus*", Mojsisovics, or the same author's unique "*Dinarites levis* (1886, pl. ix, figs. 19a, b. It will be shown below that the generic name *Danubites* cannot be used for these "obsoleti", in spite of Mojsisovics's definite restriction (1902, p. 323).

Xenoceltites spitsbergensis, sp. nov.

Plate IX, figs. 1, 2 ; Plate XI, figs. 5, 7, 8.

1921. Spath, p. 302 (*Danubites* ?, *Xenodiscus* ? *partim*).

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Xenoceltites*. Whorl-section compressed elliptical, venter arched. Bulges on inner whorls indistinct, except in var. *nodosa*, in which they are almost as pronounced as in *Olenikites*; irregular costation on outer whorls, at first strongly projected (and often constricted) on and about the periphery, but later more radial and crossing the venter in a weakened condition or broken up into indistinct secondaries, but without projection. Suture-line simple, ceratitic, with two lateral lobes and occasionally small auxiliary lobe at umbilical suture.

MEASUREMENTS :

C. 21961.	Holotype (Pl. IX, fig. 2)	. 43	·30	·22	·47
C. 27218.	Paratype I (Pl. XI, fig. 5).	70	·30	·20	·46
C. 21962.	Paratype II (Pl. XI, fig. 8)	33	·30	·23	·46
C. 27232.	Var. <i>nodosa</i> (Pl. IX, fig. 1)	40	·32	·21	·47

REMARKS. This species is very variable, but on the whole the suture-line does not differ in any essential from that of Diener's "*Dinarites minutus*" (*non* Waagen). This is only more involute than the present species and *X. gregoryi* described below, and therefore closer to *X. subevolutus*. Like the minute Salt Range original, Diener's form is, however, too immature to be definitely identified. *X. evolutus* (Waagen) differs in the development of its costation, but in the absence of its suture-line it also cannot be accurately compared. *X. gregoryi* is more compressed, less strongly costate on the outer, and smooth on the inner, whorls, and has a more crenulate and narrower periphery, but there are numerous transitions between the two species. In some of these (like Pl. XI, fig. 4) the inner whorls are sub-tuberculate, as in *X. spitsbergensis*, but the outer are indistinguishable from *X. subevolutus*.

In the var. *nodosa* (Pl. IX, fig. 1*a, b*) the resemblance to "*Xenodiscus*" *nivalis*, Diener, discussed below under *Anakashmirites*, is striking as regards ornamentation, but the low external saddle and absence of peripheral projection of the ribs are important distinguishing features.

HORIZON AND LOCALITY. Upper Eo-trias, Columbitan? Spitsbergen.

SPECIMENS :

C. 21961-2, 27218, 27232, 27237, 27243, 27252. Trident, Sassendal, Spitsbergen.

Profs. J. W. Gregory and E. J. Garwood Colls., 1896.

A number of the immature examples listed below under *X. gregoryi* may belong to the species here discussed.

***Xenoceltites gregoryi*, sp. nov.**

Plate V, fig. 3; Plate VI, figs. 4, 5; Plate XI, figs. 3, 4, 6.

1921, Spath, p. 302 (*Danubites*?, *Xenodiscus*?, *partim*); 1930, Frebold, p. 15 (*partim*).

DIAGNOSIS. *Xenoceltites* resembling *X. spitsbergensis*, but smoother and thinner, and with strongly projected constrictions across venter.

MEASUREMENTS :

C. 27220. Holotype (Pl. XI, fig. 6)	. 45	·31	·20	·44
C. 27219. Paratype (Pl. XI, fig. 3)	. 38	·30	·20	·45
C. 27221. Transitional to <i>X. spits-</i> <i>bergensis</i> (Pl. XI, fig. 4)	. 32	·31	·22	·42

REMARKS. This is the commonest form in the lowest Nodule Bed, but it is as variable as the last species, and is connected with it by numerous transitions. Many of the examples listed below, especially the immature ones, might have been included with *X. spitsbergensis*, generally distinguished in the earlier stages only by a less compressed whorl-section and more conspicuous folds. Waagen's "*Dinarites*" *evolutus* is almost identical in whorl-shape and ornamentation of the outer whorls, but its inner whorls appear to be more "leiophyllitic", whereas those of the species here described are perhaps more closely comparable to Diener's "*Ceratites*" *minutus* (*non* Waagen), with its characteristic constrictions, bordered by scale-like, overlapping ridges, but with a smaller umbilicus. Since this Siberian form, "*C.*" *minutus*, is not identical with Waagen's species from the Salt Range, it may be renamed *Xenoceltites russkiensis*, nom. nov.

The suture-line is very variable, ceratitic or goniatitic, and in at least one extreme case (Pl. V, fig. 3) rapidly ascends towards the umbilical suture, *i. e.* is strongly "inverse".

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan? Spitsbergen.

SPECIMENS :

C. 27219-22, 28648, 27214-6, 27217a, b, 27226-7, 27231, 27233, 27234-6, 27239-42, 27244-49, 27250-1, 27253-61a, b (31 young specimens), **27167-96** (juv.). Trident, Sassendal, Spitzbergen.

Profs. J. W. Gregory and E. J. Garwood Colls., 1896.

(A number of the immature examples here listed may belong to *X. spitsbergensis* and *X. subevolutus*.)

***Xenoceltites subevolutus*, Spath.**

Plate II, fig. 2; Plate VIII, fig. 2; Plate IX, fig. 4;

Plate XI, fig. 2.

1921, Spath, p. 302 (*Danubites*?, *Xenodiscus*?, *partim*); 1930, Frebold, p. 14, pl. iii, figs. 1-3 (*Xenodiscus* cf. *comptoni*), figs. 4, 5 (*Lecanites* cf. *ophioneus*).

DIAGNOSIS. *Xenoceltites* like *X. gregoryi*, but still more compressed, discoidal, and more involute, with constrictions of periphery occasionally close enough to resemble crenulations.

MEASUREMENTS :

Holotype (Frebold, pl. iii, fig. 1)	. 27	.35	.20	.39
C. 27228 (Pl. IX, fig. 4)	. 28	.40	.20	.32
C. 27229 (Pl. II, fig. 2 ; Pl. VIII, fig. 2)	. 18	.40	.20	.30
C. 27223 (Pl. XI, fig. 2)	. 34	.39	.19	.35
Frebold, pl. iii, fig. 5 (<i>Lecanites</i> cf. <i>ophioneus</i>)	. 52	.35	.21	.40

REMARKS. This species is a compressed and involute development of the stock that also produced *X. spitsbergensis* and *X. gregoryi*. It differs very little from *X. russkiensis*, which has a slightly more inflated whorl-section and less close and less strictly peripheral ornamentation, but there are forms which grade into that species as well as into *X. gregoryi*. The slight differences in the suture-lines, here figured, compared with the lobes of *X. russkiensis*, as depicted by Diener (1897, pl. ii, figs. 6c, d)—for instance, the width of the second lateral lobe—may not be of specific value considering their variability, but in a number of specimens of *X. gregoryi* and *X. subevolutus* the lobes seem to have no denticulations (see Pl. VI, fig. 5).

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ? Spitsbergen.

SPECIMENS :

C. 27223, 27228-9, 28649, 27224-5, 27230, 27238 ? Trident, Sassendal, Spitsbergen.

Profs. J. W. Gregory and E. J. Garwood Colls., 1896.

(A number of the immature examples listed above under *X. gregoryi* probably belong to the present species.)

Genus **PREFLORIANITES**, Spath.

1930, p. 90.

GENOTYPE. *Danubites strongi*, Hyatt and Smith, 1905, p. 165, pl. ix, figs. 4-6 (holotype), 7-10.

DIAGNOSIS. Evolute *Xenoceltitidæ*, with arched venters, sometimes tending to become acute, and radial ribbing most pronounced on inner lateral area and not reaching across periphery. Suture-lines with short external lobe and only two lateral lobes.

DISTRIBUTION. Upper Eo-trias, Owenitan and higher. California; Timor.

REMARKS. This genus is probably close to the stock from which sprang the Anisian *Tropigastrites* and the family Celtitidæ, to be described later. The cœnogenetic appearance of ribbed or coronate whorls in the young of Flemingitid and later stocks makes it advisable to rely for systematic purposes on the similarity in the suture-line rather than on external resemblance. Thus the Timor forms, "*Xenodiscus bittneri*"

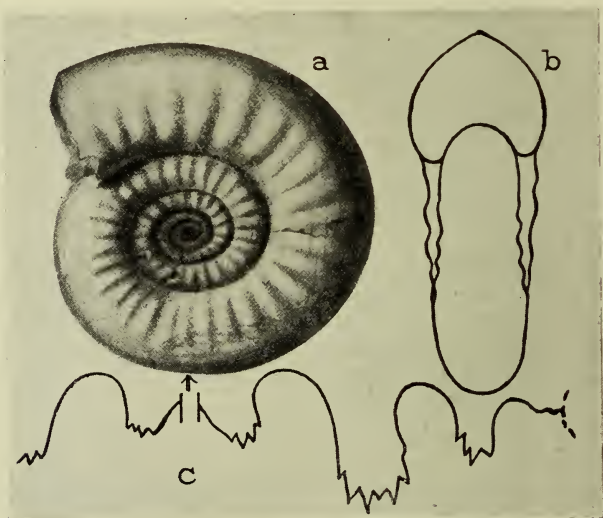


FIG. 36.—*Preflorianites strongi* (Hyatt and Smith). Side-view, sectional outline and external suture-line of holotype from the Lower Trias (*Meekoceras* Beds) of Union Wash, Inyo Range, California. (After Hyatt and Smith, 1905, pl. ix, figs. 4-6.)

(Welter, *non* Hyatt and Smith, 1922, p. 106, pl. clviii, figs. 8, 9) and *X. oyensi*, Welter (1922, p. 111, pl. clix, figs. 1, 2, 17), can be distinguished from the associated ribbed Flemingitids by their large, primitive, external saddles more definitely than by the development of the ribbing being from coarse to fine, instead of *vice versa*, as in the Flemingitids. There is a tendency to develop a sharpened ventral area in some of the forms of *Preflorianites*, but a true keel is produced only in the specialized offshoot *Inyoites*, discussed below.

In addition to the forms here described as *Preflorianites*

sulioticus (Arthaber), the Collection includes the inner whorls of a form like *Xenodiscus oyensi*, Welter, already mentioned (C. 37210), from Nifoekoko, Timor, and the fragment from a bone-bed in the *Posidonomya*-Shales of Spitsbergen, previously recorded by the writer (1921, p. 303) as resembling "*Danubites*" *strongi*, Hyatt and Smith. It is too small and incomplete to be identified with any degree of certainty. Another doubtful small example in the Koken Collection (C. 10412), labelled *Celtites acuteplicatus*, Waagen, also may represent the inner whorls of a *Preflorianites*.

Preflorianites sulioticus (Arthaber).

Plate XII, figs. 2a-d.

1911, p. 229, pl. xix, fig. 6 ; pl. xx, fig. 2 (*Xenodiscus*).

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Preflorianites*. Whorl-section first rounded, depressed, then compressed, elliptical ; venter arched. Radial, blunt ribs, tending to disappear on outer whorl. Suture-line (Pl. XII, fig. 2d) ceratitic, with low external lobe and large external saddles.

MEASUREMENTS :

Arthaber (1911, p. 229, no. 1) . . .	30	·27	·30	·47
" (" " no. 2) . . .	39	·28	·31	·48
C. 22806	44	·25	? ·25	·50

REMARKS. In his revision of the genus *Xenodiscus*, Arthaber referred to it (in addition to the Permian type-species, *X. plicatus*, Waagen) a number of costate developments of various stocks, ranging from *Glyptophiceras* (and those offshoots of —probably—the same radical stock that lead to *Xenodiscoides* on the one hand, and to Kashmiritidæ on the other) to *Wyomingites* (Meekoceratidæ) and the group of "*Danubites*" (*obsoleti*) referred to above (p. 126), and included provisionally in *Xenoceltites*. The acquisition of ribs by a number of smooth stocks is no criterion of genetic affinity, nor is the equally erratic development of keels or grooves on originally arched venters. On the other hand, apart from the smaller size and simpler suture-line, *Preflorianites sulioticus* is probably connected with the typically Anisian *Danubites*, e. g. *Danubites ambika*, Diener (1895b, p. 104, pl. xxix, figs. 2a-c), from the "*binodosus*" horizon of Tibet, with which Arthaber compared it. There seems to be a perfect continuity from the Upper

Eo-trias onward, so that the present genus might also have been included in Danubitidæ, if it were not for the fact that it is also at least as closely connected with Celtitidæ through the intermediate *Tropigastrites*.

The two species of *Xenaspis* described by Arthaber as *X. mediterranea* (1908, p. 261, pl. xi, fig. 3) and *X. enveris* (1911, p. 230, pl. xx, fig. 3), and based on unique and imperfect examples, are altogether doubtful, but have certainly nothing to do either with the true Permian *Xenaspis carbonaria*, Waagen, or the "*Xenodiscus*" here discussed. On the other hand, Arthaber's *Celtites arnauticus* (1911, p. 267, pl. xxiv, fig. 7), here included in *Arnautoceltites*, has no connection with the true Celtitidæ that originated in *Preflorianites*.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan. Albania.

SPECIMENS :

C. 22805-20. (Metatypes.) Kçira, Albania.

Baron F. Nopcsa Coll., purchased 1922.

INCERTÆ SEDIS.

? Genus **HEMILECANITES**, nov.

GENOTYPE. *Lecanites discus*, Arthaber, 1908, p. 268, pl. xi, figs. 5a-c.

DIAGNOSIS. ? Xenoceltitidæ, more or less micromorph, suturally reduced, smooth; evolute, with tendency to oxynote venter and with constricted mouth-border and ventral lappet (Pl. XIII, figs. 7a-d).

DISTRIBUTION. Upper Eo-trias, Owenitan (= Meekoceratan) and Columbitan. California; Albania.

REMARKS. The inclusion of *Hemilecanites* in the family Xenoceltitidæ is provisional. It has already been mentioned that "*Lecanites*" *knechti*, Hyatt and Smith, may be a simplified Flemingitid, and is believed to be more closely related to the primitive forms of that family (e. g. *Dieneroceras*), with evolute and smooth whorls, than to the Ladinian *Lecanites glaucus* (Münster). Similarly, "*Paralecanites*" *arnoldi*, Hyatt and Smith, connects *Wyomingites*, its less simplified ally, and the Meekoceratidæ with the same fundamental (Ophiceratoid) stock. These *Lecanites*-like simplified offshoots, with entire suture-lines, of course may occur in any stock; thus the Anisian *Proavites*, to which Arthaber and Diener referred some

"*Lecanites*" forms, is here taken to be probably a Meekoceratid, akin to the early Noritids, the affinity being indicated especially by the positions and proportions of the (secondarily entire) lobes and saddles (compare pl. viii, fig. 2 and pl. x, fig. 4c in Arthaber, 1896). It is thus not impossible that some of the Albanian "*Lecanites*", like "*L.*" *skutarensis*, Arthaber, or "*L.*" *discus*, described below, may even represent offshoots of *Eophyllites*, so abundant in the same beds; just as, again, the unique "*Lecanites*" *sybillinus*, Frech (1911, p. 17, pl. ii, fig. 4), is probably a simplified offshoot of that stock (generally referred to as "*Xenaspis*"), which also gave rise to *Leiophyllites* and the Gymnitidæ. The bicarinate sculptured forms, like "*L.*" *niazi*, Arthaber (1911, p. 238, pl. xxi, figs. 3a-c), probably belong to yet a different family, but have no connection with the Gyronitid genus *Catalecanites*. It is obviously impossible to include all these heterophyletic offshoots in one sub-family, Lecanitinæ, Arthaber (1911, p. 237), but unfortunately our knowledge of these, at present, is too incomplete for a final classification.

Another new species seems to be represented by a small example (C. 37211, from the *Albanites* Bed, Nifoekoko, Timor) which, at 14 mm. diameter, shows the complete mouth-border with ventral lappet. Unfortunately, the crystalline matrix destroyed all traces of the suture-line, and the similarity to the more evolute *H. discus* may be purely accidental.

Hemilecanites discus (Arthaber).

Plate XIII, figs. 7a-d.

1908, p. 268, pl. xi, figs. 5a-c; 1911, pp. 181, 238.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Hemilecanites*. Whorl-section elliptical, with greatest thickness near the rounded umbilical slope, and sharpened if not actually oxynote venter. Smooth, shallow constriction just before peristome, with ventral lappet. Suture-line entire, with three rounded saddles in a line.

MEASUREMENTS :

Arthaber (1908, pl. i, figs. 5a-c)	.	26	·30	·20	·50
Pl. XIII, figs. 7a-c (C. 22376)	.	18	·33	·23	·44

REMARKS. The resemblance of this peculiar species to Waagen's "*Lecanites*" *planorbis* (1895, p. 278, pl. xxxix, fig. 3)

is superficial, the Indian form being probably merely a weathered *Gyronites* of the group of *G. vermiformis*, Waagen, discussed above (p. 93) under *Gyrophiceras*. Arthaber's *Lecanites skutarensis* (1911, p. 237, pl. xxi, figs. 1a-c), based on a unique specimen, has a similar mouth-border, but a more inflated whorl-section and slender saddles, and may be merely a homœomorphous offshoot of another stock. It seems particularly close to Arthaber's "*Xenaspis*" *mediterranea* (1908, p. 260, pl. xi, figs. 3a-c), which again has the same mouth-border, but the whorl-shape of *Eophyllites* or *Leiophyllites*, and a slightly simpler suture-line than *Ussurites* (?) *decipiens*.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan. Albania.

SPECIMENS :

C. 22875-8. Metatypes. Kçira, Albania.

Baron F. Nopcsa Coll., 1922.

2. Sub-family INYOITINÆ, nov.

DIAGNOSIS. Highly keeled *Xenoceltitidæ*, being compressed offshoots of the same stock that produced *Preflorianites*, with similar costation degenerating into striation and comparable ceratitic suture-line.

REMARKS. In addition to the genus *Metinyoites*, nov., included here provisionally, there is only the genus *Inyoites*, Hyatt and Smith, comprising one large and variable species, *I. oweni*, Hyatt and Smith. The four metatypes available, from Prof. J. Perrin Smith's own collection, differ, however, considerably in details of costation, and the original figures in Hyatt and Smith (1905, p. 134, pl. vi, figs. 1-17; pl. lxix, figs. 1-9; pl. lxxviii, figs. 1-8) also show differences in ribbing and suture-lines—characters that in some of Mojsisovics's Alpine forms have been held to be of specific value. Although we retain all these in one species, since they presumably formed one interbreeding population, a separate sub-family for this specialized branch seems advisable, and there is no connection either with *Hungarites*, a keeled "Ceratite", or such carinate offshoots as *Discotoceras*, *Metotoceras*, *Vishnuites*, *Aspenites*, etc., here discussed. *Metinyoites* seems to attach itself to such striate forms of *Inyoites* as that figured by Hyatt and Smith in pl. lxix, fig. 2; but it also shows a curious resemblance to large examples of the contemporary "*Meekoceras*" *wanneri*, Welter.

Genus INYOITES, Hyatt and Smith.

1905, p. 134, Smith, 1932, p. 80.

GENOTYPE. *I. oweni*, Hyatt and Smith, 1905, p. 134, pl. vi, fig. 1 (lectotype).

DIAGNOSIS. Inyoitinae with subplatygyral, subleptogyral, subangustumbilicate coiling; with flattened side, with distinct

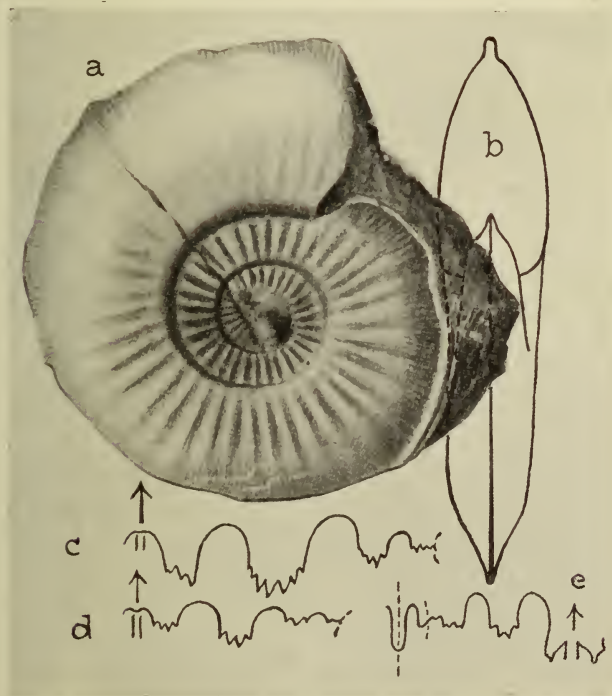


FIG. 37.—*Inyoites oweni*, Hyatt and Smith. Side-view of lectotype (a), sectional outline (b) and suture-lines (c-e) of other examples from the Lower Trias, Meekoceras Beds, of the Inyo Range, California. (After Hyatt and Smith, 1905, pl. vi, figs. 1, 2, 8, 12, and pl. lxix, fig. 3.)

umbilical edge and straight costæ, most pronounced on inner lateral area, and breaking up into striæ towards a compressed venter. High, hollow keel. Suture-line ceratitic, with high median saddle in ventral lobe (figs. 37c-e) and entire dorsal lobe.

DISTRIBUTION. Upper Eo-trias, Owenitan (= Meekoceratan). California; Indo-China (?).

INCERTÆ SEDIS.

? Genus **METINYOITES**, Spath.1930, pp. 29, 89. *Supra*, p. 85.GENOTYPE. *Vishnuites discoidalis*, Welter, 1922, p. 138, pl. clxvii, figs. 1, 2.

FIG. 38.—*Metinyoites discoidalis* (Welter). Side-view and sectional outline (along fracture in *a*) of holotype, from the Lower Trias of Nifoekoko, Timor. (After Welter, 1922, pl. clxvii, figs. 1, 2.)

DIAGNOSIS. ? Inyoitinae with discoidal, highly keeled shells, with radial striation as in Inyoites, but more specialized suture-line.

DISTRIBUTION. Upper Eo-trias, Owenitan (= Meekoceratan). Timor.

REMARKS. The resemblance of this genus, known at present in only one Timor example, to the earlier *Vishnuites*, is superficial, and the differences in the striation alone are sufficient for separation. In this respect, there is great similarity to the peculiar striation shown in those specimens of *Inyoites oweni* in which the primary ribs are indistinct, but the pointed saddles of the suture-line of *Metinyoites* indicates specialization in quite a different direction. Compared with the suture-line of an immature *Inyoites oweni* (see Hyatt and Smith, 1905, pl. lxxviii, fig. 1), the difference in the size of the external saddle is important, and prevents definite reference of *Metinyoites* to the present sub-family; but in larger specimens of *Inyoites oweni* (Hyatt and Smith, 1905, pl. vi, fig. 2, pl. lxix, fig. 1) this difference is far less pronounced. Moreover, in forms of Paranoritids (e. g. *Clypeoceras*) and Proptychitids, etc., similar pointing of the saddles has been noticed, and in *Lanceolites* specialization is still more extreme.

The peculiar resemblance of Welter's form to the numerous, large "*Meekoceras*" *wanneri* in the Collection has already been referred to (p. 136).

D. Family PARANORITIDÆ, Spath.

1930, p. 13. Meekoceratidæ, Waagen, *partim*, incl. Aspiditina, Waagen).

DIAGNOSIS. More-or-less involute, discoidal Ammonoidea with flattened sides and rounded or truncate peripheries, which tend to sharpen. Suture-lines ceratitic, with auxiliaries becoming more individualized. Internal lobe lituid (fig. 39).

REMARKS. The genera that are here referred to the Paranoritidæ were, at one time, all included in Meekoceratidæ. Diener, indeed, in 1915 still considered *Clypeoceras* (= "*Aspidites*", with *Kingites*) and *Koninckites* to be sub-genera of *Meekoceras*, and listed *Prionolobus* (discussed above) and *Paranorites* as synonyms of that genus. But the Meekoceratidæ, as here restricted, include homœomorphs of these earlier genera, and are distinguished from the Paranoritids by different proportions of the sutural elements and by different stages of development, without tendency to involution or sharpening of the periphery. The genera here grouped in the family Paranoritidæ form a fairly homogeneous group, but it is probable

that, like Gyronitidæ, they have a polyphyletic origin in the Ophiceratidæ. The Proptychitidæ, discussed below, are closely connected with Paranoritids by their suture-lines (see fig. 39a, b), but produce various types of inflated whorl-shape that make it desirable to keep them separate as a family Proptychitidæ, as Waagen did in 1895.

This author's four sub-families constituting the "Meekocera-tidæ", based chiefly on umbilication and suture-line, do not thus differ so very materially from the divisions here adopted; but the genus *Meekoceras* itself having been misinterpreted, and *Aspidites* being pre-occupied, it is necessary to substitute Paranoritidæ for the family that includes *Clypeoceras*, Smith

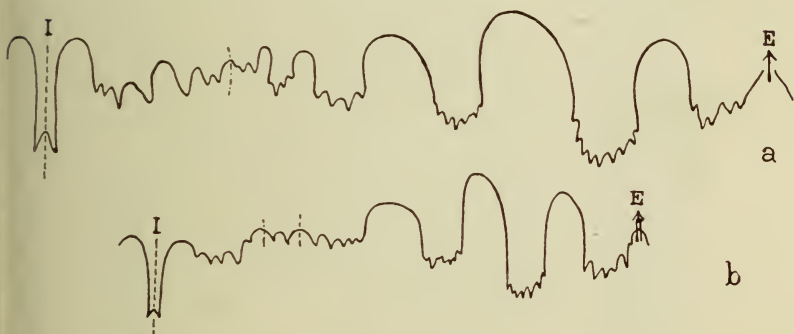


FIG. 39.—Suture-lines of *a*, *Paranorites gigas* (Waagen). Lower Eo-trias, Ceratite Sandstone. Salt Range. (After Waagen, 1895, pl. xxxi, fig. 2c, reduced to $\frac{2}{3}$ linear.) *b*, *Proptychites markhami*, Diener. Lower Eo-trias. Shalshal Cliff, Himalayas. (After v. Krafft and Diener, 1909, pl. xiii, fig. 5, reduced to $\frac{2}{3}$ linear and reversed.)

(= "*Aspidites*", Waagen); as well as *Koninckites* and *Kingites*, Waagen; in addition to *Paranorites*, Waagen, referred by its author to Noritidæ; and the new genera *Paraspidites* and *Pseudaspidites*, discussed below.

Genus **PARANORITES**, Waagen, 1895, p. 157.

GENOTYPE. *P. ambiensis*, Waagen, 1895, p. 158, pl. xxii, fig. 1.

DIAGNOSIS. More-or-less evolute, discoidal Paranoritidæ with narrowly rounded periphery and slightly convex sides, high but rounded umbilical wall, and ceratitic suture-line, with external saddles and lobes more differentiated than in *Ophiceras* or *Prionolobus*.

DISTRIBUTION. Lower Eo-trias (Ceratite Marls), Upper Gyronitan and Flemingitan. Salt Range.

REMARKS. The genotype, the only form of this genus described by Waagen, was considered by Frech (in Noetling, 1905, pl. xxiv) to be identical with "*Prionolobus*" *volutus*. Whether this identification is accepted or not, it seems advisable to use Waagen's term, *Paranorites*, for those "*Koninckites*" (*K. volutus* and *K. gigas*, Waagen) which Frech referred to *Prionolobus*. For the type of the last, as mentioned above, belongs to a different stock. Philippi (1901, p. 107) identified *Paranorites* with Waagen's *Proptychites*, but this cannot be accepted. Of Waagen's *Meekoceras*, those of the type of

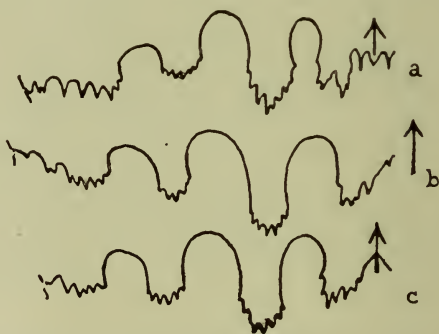


FIG. 40.—External suture-lines of *Paranorites*. *a*, *P. ambiensis*, Waagen. *b*, *P. hydaspis* (Koken MS), sp. nov. *c*, *P. pulchrus* (Waagen). Lower Eo-trias. Salt Range. (*a* and *c* after Waagen, 1895, pl. xxii, fig. 1d, corrected, and pl. xxix, fig. 1c; *b* from specimen C. 10448.)

"*M.*" *magnumbilocatum* are referable to the present genus, and the writer would also provisionally include here "*Aspidites*" of the type of "*A.*" *kingianus*, Waagen; although in these later forms the high umbilical slope causes a somewhat different aspect.

***Paranorites ambiensis*, Waagen.**

Text-fig. 41.

1895, p. 158, pl. xxii, fig. 1 (holotype); 1905, Frech, pl. xxiv, fig. 1a (*Prionolobus*); 1915, Diener, p. 216.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Paranorites*. Sides slightly convex, greatest whorl-thickness

close to the high, vertical, umbilical wall. Venter indistinctly tabulate on test, rounded on cast. With indistinct falcoid ribbing. Suture-line ceratitic, with external lobe and saddle considerably subdivided.

MEASUREMENTS :

Waagen's type	102	.45	.22	.27
C. 10421	108	.44	.22 ?	.28



FIG. 41.—*Paranorites ambiensis*, Waagen. Lower Eo-trias, "Ceratite Sandstone". Amb, Salt Range. (After Waagen, 1895, pl. xxii, figs. 1a, b.)

REMARKS. This distinctive species, described in great detail by its author, was considered by Frech to represent merely the chambered casts, whereas specimens of the same form, according to this author, when showing body-chamber and ornamentation, had been described under a different name, *Koninckites volutus*, Waagen. Frech, therefore, included both forms in his comprehensive "*Prionolobus volutus*"; but it seems to the writer that the latter form can be distinguished while still young by its slightly larger umbilicus and a slightly

more inflated whorl-section. *Paranorites pulchrus* (Waagen), *P. lyellianus* (de Koninck) and *P. gigas* (Waagen) have a still greater whorl-thickness; on the other hand, *P. vercheri* (de Koninck), generally similar to the species here described, has less differentiated external lobe and saddles.

HORIZON AND LOCALITIES. Lower Eo-trias, Ceratite Marls. Salt Range.

SPECIMENS :

C. 10421. Virgal, Salt Range. *Koken Coll., purchased 1905.*

C. 13363-4. Two fragments of casts. Between Wascha Mine and Sakesur Peak, Salt Range.

Presented by E. G. Brook Fox, 1896.

***Paranorites vercheri* (Waagen).**

Koninckites vercheri, Waagen, 1895, p. 265, pl. xxx, figs. 1a-d (holotype); *Meekoceras (Koninckites) vercheri* (Waagen), Diener, 1915a, p. 198.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Paranorites*. Agreeing in whorl-shape with *P. ambiensis*, but with a simpler suture-line and different relative proportions of the three saddles.

MEASUREMENTS :

Waagen's type . . . 73 . 45 . 22 . 30

REMARKS. Whether this species is really different from *P. ambiensis*, or whether the reduced suture-line is due to the usual weathering of the casts, cannot be definitely determined without an examination of Waagen's type. One of the examples before the writer (C. 10442), identified by Koken as "*Koninckites vercheri*", has an external saddle almost as "noritic" as that of *P. ambiensis*, but a definite auxiliary lobe and saddle. Another specimen in the same collection (C. 10452), labelled "*Aspidites kingianus*", but in whorl-shape indistinguishable from the two species here discussed, shows greater resemblance in its suture-line to *P. vercheri*. Weathering, however, is here probably the cause of the simpler suture-line, and the specific separation from such examples of *P. ambiensis* as that quoted above under C. 13364 is based merely on the different proportions of the three saddles.

Koninckites timorensis (Wanner, 1911, p. 185, pl. vi, figs. 2, 3, pl. vii, figs. 5, 6) has a smaller umbilicus than the present species; it is somewhat transitional to such more advanced genera as *Kingites* and *Clypeoceras*.

HORIZON AND LOCALITIES. Lower Eo-trias, Ceratite Marls. Salt Range.

SPECIMENS :

C. 10442. Lower Ceratite Marls. Chideru, Salt Range.

C. 10434, C. 10444. Ditto.

C. 10458. Ditto. Crushed and worn.

C. 10452. (Labelled "*Aspidites kingianus*".) Virgal, Salt Range. All from Koken Coll., purchased 1905.

Paranorites hydaspis (Koken MS.), sp. nov.

Plate IX, figs. 3a, b.

TYPE. B.M., C. 10448, ex Koken Coll. (*Xenodiscus hydaspis*, Koken MS.).

DIAGNOSIS. Subplatygyral, subleptogyral, sublatumbilicate *Paranorites*. Whorl-shape as in the two previous species, but with more open umbilicus; suture-line with less "noritic" external saddle than *P. ambiensis*, but similar auxiliaries (see fig. 40b, p. 142).

MEASUREMENTS :

Holotype, C. 10448)	.	.	120	.	·38	.	·22 ?	.	·34
Paratype, C. 13362)	.	.	200	.	·40	.	·21 ?	.	·35

REMARKS. The holotype of this species, except in small details of the suture-line, differs from *P. ambiensis* merely in having a larger umbilicus. The larger paratype consists of a fragment comparable to Waagen's large "*Koninckites*" *volutus* (pl. xxviii, fig. 1 = lectotype), but having also a wider umbilicus. The suture-line of the present species is greatly projected at the umbilical end, as in *P. gigas* (Waagen), but this form has a greater whorl-thickness. The example figured by Frech as "*Prionolobus volutus*" (pl. xxiv, fig. 1a), with an umbilicus of 32% at 100 mm. diameter, i. e. already wider than that of *P. ambiensis*, seems to be somewhat intermediate between this and the present species. Its suture-line differs only slightly in the auxiliary series.

HORIZON AND LOCALITIES. Lower Eo-trias, Ceratite Marls. Salt Range.

SPECIMENS :

C. 10448. Holotype. Chideru, Salt Range.

Koken Coll., purchased 1905.

C. 13362. Between Wascha Mine and Sakesur Peak, Salt Range. Paratype, fragmentary, corroded.

Presented by E. G. Brook Fox, 1896.

(?) **C. 10436.** Chideru, Salt Range. A badly corroded example, possibly even a large *Flemingites*, labelled by Prof. Koken "*Xenodiscus peramplus*, Koken". The apparent costation, however, may be simply the result of weathering, and the specimen may belong to one of the more evolute forms of *Paranorites*, like the species here discussed. *Koken Coll., purchased 1905.*

Paranorites cf. pulchrus (Waagen).

Meekoceras pulchrum, Waagen, p. 249, pl. xxix, figs. 1a-c (non xxvii, figs. 2 and 3?).

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Paranorites*. Whorl-shape more inflated than in *P. ambiensis* and umbilicus smaller. Suture-line with only slightly simpler external lobe (see fig. 40c, p. 142).

MEASUREMENTS :

Waagen's type (figure)	. 103	. .47	. .23	. .22
" " (text)	. 103	. .47	. .24	. .26
C. 10453	. 170	. .40	. .20 ?	. .26

REMARKS. There does not seem to be sufficient reason for separating this species generically from the typical *Paranorites* with equal excentrumbilication and similar suture-lines; but since Waagen's figures may be misleading, definite identification with this species of the poorly preserved material available is out of the question. The third example above quoted shows a larger umbilicus, but smaller whorl-height than Waagen's type, which, considering its large diameter, seems to agree with the normal rate of opening out of the umbilicus in all the forms of *Paranorites*. The example was labelled by Koken "*Koninckites volutus*", but it has already been pointed out that in this form the umbilicus is considerably more open and the shape is less discoidal than in *P. pulchrus*.

A greatly corroded cast (C. 10424), labelled with the MS. name "*Koninckites scaphitoides*, Koken", seems to be closer to the present than to the other species of *Paranorites* here discussed owing to its small umbilicus, but it cannot be safely determined, even generically.

HORIZON AND LOCALITIES : Lower Eo-trias, Ceratite Marls.
Salt Range.

SPECIMENS :

C. 10453. Virgal, Salt Range. Koken Coll., purchased, 1905.

C. 10424. *Ibid.* (corroded, doubtful cast).

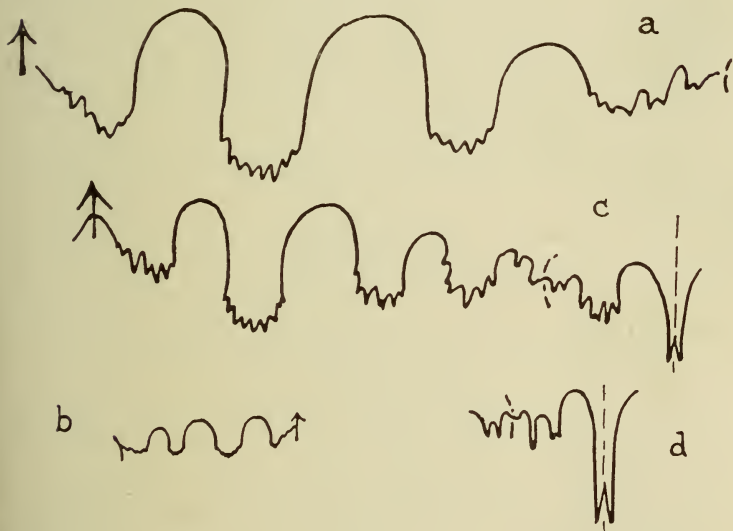


FIG. 42.—*a*, Suture-line of *Paranorites præstans* (Koken MS.), sp. nov. From specimen C. 10457 at diameter of 200 mm. *b*, *Paranorites inflatus* (Koken MS), sp. nov. From specimen C. 10441 at diameter of 45 mm. *c*, *Paranorites volutus* (Waagen). (After Frech, 1905, pl. xxiv, fig. ϵ (reversed) [*Prionolobus*”, Frech = “*Koninckites*”, Waagen].) *d*, Internal lobe of *Proptychites undatus*, Waagen. (After Frech, 1905, pl. xxiv, fig. ϵ_2 [*Prionolobus*”].) All from Lower Eo-trias. Salt Range.

***Paranorites præstans* (Koken MS.), sp. nov.**

(Plate VII, figs. 4*a*, *b*.)

TYPE. B.M., C. 10457, ex Koken Coll. (*Koninckites præstans*, Koken MS.).

DIAGNOSIS. Subplatygyral, subleptogyral, sublatumbilicate *Paranorites*. Whorl-section, shape and suture-line (fig. 42*a*) as in *P. gigas* (Waagen), but with smaller umbilicus.

MEASUREMENTS :

Holotype (C. 10457) . 220 . .38 . .23 . .33

REMARKS. This species agrees with *P. gigas*, even to the presence of an indistinct spiral groove on the outer whorl; but its umbilicus is only 33% of the diameter, as against 36% in the example of *P. gigas* figured by Frech (1905, pl. xxvii, fig. 2), and 38% as estimated by Waagen. The large holotype of the present species has its last septum situated at a diameter of 200 mm., but its inner whorls are obscured. It is probable, however, that these were more evolute than either those of *P. æqualis* described below or those of the more rounded *P. lyellianus* (de Koninck). But the suture-lines are almost identical in all these "species".

HORIZON AND LOCALITIES. Lower Eo-trias, Ceratite Marls. Salt Range.

SPECIMENS :

C. 10457. Holotype. Virgal, Salt Range.

Koken Coll., purchased, 1905.

Paranorites æqualis (Koken MS.), sp. nov.

Plate X, figs. 3a, b.

TYPE. B.M., C. 10435, ex Koken Coll. (*Koninckites æqualis*, Koken MS.).

DIAGNOSIS. Subplatygyral, subleptogyral, subangustum-bilicate *Paranorites*; sides compressed, evenly rounded, venter tabulate, with rounded edges. Suture-line as in *P. gigas*, *P. præstans* and allies.

MEASUREMENTS :

Holotype, C. 10435 . . . 115 . . 44 . . 24 . . 26

REMARKS. This species differs very little from *P. præstans*, and the writer was at first inclined to regard them both as belonging to *P. gigas*, which was founded by Waagen on a mere fragment. Taking, however, Frech's better specimen (1905, pl. xxvii, fig. 2) to represent this last species in the restricted sense, it will be seen that the dimensions of the three forms are perhaps sufficiently distinct for specific separation, following Koken. The holotype of the present species, though young, already shows one-third of a whorl of body-chamber, in which can be seen the natural cross-section of another form of *Paranorites*, with almost sulcate, bicarinate periphery. "*Meekoceras*" *pulchrum*, Waagen, resembles the species here described in whorl-section, but has a more concentric umbilicus; and if the two small examples with rounded periphery figured by

Waagen (in pl. xxvii, fig. 2) actually belong to the same form, it cannot be very closely allied.

Paranorites lyellianus (de Koninck), as interpreted by Waagen (1895, p. 270, pl. xxx, figs. 3a-c), also differs from *P. æqualis* chiefly in the rounding of the periphery, but this may have been exaggerated in Waagen's restored figure, and in the present species the peripheral edges are also rounded on the outer whorl—a character that distinguishes all the forms of the *gigas-kingianus* group from the more typical *Paranorites ambiensis*.

HORIZON AND LOCALITIES. Lower Eo-trias, Ceratite Marls. Salt Range.

SPECIMENS :

C. 10435. Holotype. Virgal, Salt Range, India.

Koken Coll., purchased, 1905.

Paranorites inflatus (Koken MS.), sp. nov.

Plate IV, fig. 1.

TYPE. B.M., C. 10441, *ex* Koken Coll. (*Koninckites inflatus*, Koken MS.).

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Paranorites*. Sides compressed, flattened; venter tabulate. Suture-line as in *P. volutus* and allies (see fig. 42b, p. 147).

MEASUREMENTS :

Holotype (**C. 10441**) . . . 68 . 47 . 27 . 20

REMARKS. The holotype of this species has the whorl-shape of the small example of "*Meekoceras*" *planulatum* (de Koninck), figured by Waagen (1895, pl. xxiv, figs. 2a-c). Since the suture-line, however, of this specimen is unknown, and de Koninck's original figure of his species (1863, pl. v, fig. 1) is obviously useless, exact comparison is impossible. Waagen's small example of "*Koninckites*" *volutus* (pl. xxviii, figs. 2a, b) differs from the form here discussed mainly in its wider umbilicus; this is also still more open in *P. vercheri* than in *P. inflatus*; moreover, the whorl-section in the umbilical region is not inflated. *P. lyellianus*, with high umbilical wall, as drawn by Waagen, differs in its rounded periphery.

Of the three examples in the Koken Collection, labelled "*Koninckites*" *inflatus*, the largest may owe its inflation entirely to mineralization, and specific identification must remain doubtful. In any case this example seems to

agree with a specimen in the same collection (C. 10439), marked "*Koninckites volutus*, Waagen, einseitig deformiert". The umbilicus of both these doubtful examples is smaller than that of *P. volutus*, but larger than that of the holotype of the present species; so their inclusion here is provisional. Specific identification, moreover, of the third example is still less certain; it differs from a similarly crushed specimen of *P. vercheri*, referred to above (C. 10458) merely in having a wider periphery. If it belong to *P. inflatus*, it indicates that the umbilicus widens with age, so that identity even with *P. ambiensis* might be claimed. Its internal lobes agree fairly well with those of *P. volutus*, as figured by Frech (see fig. 42c, p. 147).

HORIZON AND LOCALITIES. Lower Eo-trias, Ceratite Marls (Upper Gyronitan and Flemingitan). Salt Range.

SPECIMENS :

C. 10441. Holotype. Chideru, Salt Range.

Koken Coll., purchased, 1905.

C. 10416. *Ibid.* Crushed inner whorls.

C. 10419. *Ibid.* Doubtful large example, imperfectly preserved.

C. 10439. *Ibid.* Doubtful, labelled "*Koninckites volutus*", deformed on one side.

Genus **KONINCKITES**, Waagen, 1895, p. 253.

GENOTYPE. *K. vetustus*, Waagen, 1895, p. 261, pl. xxvii, figs. 4a-d.

A. v. Krafft (in v. Krafft and Diener, 1909, p. 65) considered "*K.*" *yudishthira*, Diener, to be the "prototype", and Diener (1915a, p. 180) listed this species as "cotype"; but the selection by Hyatt and Smith (1905, p. 148) of Waagen's species as type of the present genus is decisive.

DIAGNOSIS. Paranoritidæ with platygyral, subleptogyral, subangustumbilicate coiling. Sides flattened, venter narrowly rounded to subtabulate, umbilical wall gently rounded. Suture-line (fig. 43, p. 152) ceratitic, with tendency to advance the individualization of the elements in the auxiliary series.

DISTRIBUTION. Lower Eo-trias, Gyronitan (and Flemingitan?). Salt Range and Himalayas.

REMARKS. The genus *Koninckites* is here restricted to the more involute forms of the *dauidsonianus* group with rounded or subtabulate peripheries. Some of Waagen's *Koninckites*, like *K. volutus*, are referred to *Paranorites*; others, like *K. impressus*, to *Prionolobus*, with an essentially similar suture-line and

tabulate periphery, but remaining evolute. A. v. Krafft (1909, p. 8) was undoubtedly right in stating that "the systematic value of differences in the auxiliary series had altogether been greatly overrated by Waagen, because they were far from being defined sharply, as was evident from Waagen's own classification". It must be admitted, with v. Krafft, that if "*Koninckites*" *gigas* belonged to the present genus, then "*Aspidites*" *magnumbilocatus*, Waagen, also would have to be referred to it; nevertheless, on account of their vertical umbilical edge, both are here included in *Paranorites*. Whether Krafft's "prototype" of *Koninckites*, namely, *K. yudishthira*, Diener, from the *Hedenstræmia* Beds, here referred to *Pseudaspidites*, is a descendant of the earlier true *Koninckites* seems very doubtful.

***Koninckites davidsonianus* (de Koninck).**

Plate V, fig. 2.

1863. *Ceratites davidsonianus*, de Koninck, Quart. J. Geol. Soc., xix, p. 13, pl. vi, fig. 2 (holotype).

1863. *Ceratites davidsonianus*, de Koninck, Foss. paléoz. Inde, p. 10, pl. vi, fig. 2.

1915. *Meekoceras davidsonianum* (de Koninck), Diener (*a*), p. 191, *partim*.

DIAGNOSIS. Platygyral, subleptogyral, angustumbilicate *Koninckites*. Sides flattened, with rounded umbilical edge and arched venter. Suture-line ceratitic, with small auxiliary lobe.

REMARKS. Waagen's *Koninckites davidsonianus*, here renamed *K. truncatus*, sp. nov., and the species described below as *K. apertus* (Koken), sp. nov., are less closely allied to the genotype, namely, *K. vetustus*, than is *K. davidsonianus*. In fact, de Koninck's original differs from *K. vetustus*, Waagen, merely in having a smaller umbilicus. In this respect it agrees with *K. truncatus*, but the latter has a tabulate periphery. *K. ovalis* and "*K.*" *lyellianus*, Waagen, of higher beds, are characterized by a still larger umbilicus.

The dimensions of the holotype are: 57-53-? .22-.12. They are almost identical with those of *K. truncatus*, as recorded by Waagen. Since de Koninck's original figure is diagrammatic, the holotype is now refigured (Pl. V, fig. 2).

"*Meekoceras*" *kyokticum*, v. Krafft (in v. Krafft and Diener, 1909, p. 52, pl. ii, figs. 8a-c), which seems to belong to the present genus in spite of its simple external lobe, and the equally excentrumbilicate *Koninckites krafftii*, Spath (1930, p. 28 =

Meekoceras varaha, Diener, in Krafft and Diener, 1909, p. 17, pl. ii, figs. 4a-d, non "*Kingites*" *varaha*, Diener, 1895, pl. i, figs. 2a-c, are more closely comparable with the species described below (see figs. 43a-c).

HORIZON AND LOCALITIES. Lower Ceratite Limestone (Gyronitan). Salt Range.

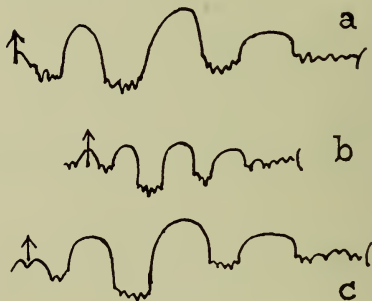


FIG. 43.—Suture-lines of *Koninckites*. a, *K. davidsonianus* (de Koninck). From holotype, C. 21967. b, *K. truncatus*, nom. nov. (After Waagen, 1895, pl. xxxiii, fig. 4d.) c, *K. krafftii*, Spath. (After v. Krafft and Diener, 1909, pl. ii, fig. 4c.) ("*Meekoceras varaha*, Diener.") Lower Eo-trias. a, b, Salt Range; c, Himalayas.

SPECIMENS :

C. 21967. De Koninck's holotype, labelled "Productus Limestone, Vurcha, Punjaub".

Presented by Geol. Soc., 1911.

C. 10417b. Chideru, Salt Range, Pubjab, India.

Koken Coll., purchased, 1905.

C. 15440. From near Kushab, Shaipur District, Salt Range. (A poorly preserved, doubtful example.)

Presented Capt. F. W. Parish, 1913.

Koninckites truncatus, nom. nov.

Fig. 44.

1895. *Koninckites davidsonianus*, Waagen (non de Koninck, sp.), pl. xxxiii, figs. 4a-d (holotype).

1915. *Meekoceras davidsonianum* (de Koninck), Diener (a), p. 191, *partim*.

DIAGNOSIS. Platygyral, subleptogyral, angustumbilicate *Koninckites*. Sides flattened, with rounded umbilical edge and truncate venter. Suture-line (fig. 43b, p. 152) ceratitic, with small auxiliary lobe.

REMARKS. The dimensions of this species, as recorded by Waagen (61-·53-·23-·13), are almost the same as those of *K. davidsonianus*; but it has already been pointed out that in the latter species the periphery is arched, not truncate or tabulate. A topotype of the present species is in the Koken Collection (C. 10417a, erroneously labelled "*Proptychites discoides*, Waagen", associated with an example of a true *Koninckites davidsonianus*, C. 10417b, listed above). It shows

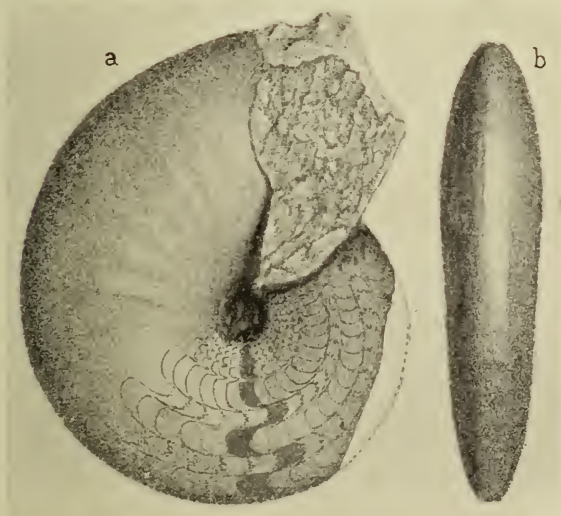


FIG. 44.—*Koninckites truncatus*, nom. nov. Lower Eo-trias. Salt Range. (After Waagen, 1895, pl. xxxiii, figs. 4a, c (= "*Koninckites davidsonianus*")).

the tabulation of the periphery more distinctly on the camerated portion. In *K. apertus* the body-chamber similarly tends to arching of the ventral area. *K. krafftii*, Spath, mentioned above, also shows this character, but differs from *K. truncatus* in its thicker outer whorl with higher umbilical slope and excentric umbilicus.

HORIZON AND LOCALITIES. Lower Eo-trias, Lower Ceratite Limestone (Gyronitan). Salt Range.

SPECIMENS :

C. 10417a. Chideru, Salt Range. **C. 10427.** Same (immature).
Koken Coll., purchased, 1905.

Koninckites apertus (Koken MS.), sp. nov.

Plate XI, fig. 1.

TYPE. B.M. C. 10440, ex Koken Coll. (*Koninckites davidsonianus* [de Koninck], var. *aperta*, Koken MS.).

DIAGNOSIS. Platygyral, subleptogyral, angustumbilicate, excentrumbilicate *Koninckites*. Sides flattened, with low umbilical rim. Venter tabulate on camerated portion, tending to round off on body-chamber. Suture-line ceratitic, as in two previous species.

REMARKS. This species differs from *K. truncatus* merely in the opening out of its umbilicus on the last whorl. *K. davidsonianus* has an arched periphery throughout, and *K. oclusus*, sp. nov., described below, is characterized by its very small umbilicus.

K. krafftii, Spath, with similar excentric umbilicus, differs from the present species in greater whorl-thickness. *K. kyokticus* (Krafft), on the other hand, has a different suture-line.

"*Meekoceras*" *hodgsoni*, Diener (1897, p. 133, pl. vi, fig. 1), which, on account of its discoidal shape, shows resemblance to *Koninckites apertus*, is distinguished therefrom by its concentric open umbilicus, with well-defined border and a more *Prionolobus*-like suture-line.

"*Aspidites*" *ensanus*, v. Krafft (in v. Krafft and Diener, 1909, pl. v, figs. 5a-c, lectotype), seems to differ from the form here described chiefly in its more advanced suture-line. It is transitional between *Koninckites* and *Clypeoceras*.

HORIZON AND LOCALITIES. Lower Ceratite Limestone (Gyronitan). Salt Range.

SPECIMENS :

C. 10440. Chideru, Salt Range. Koken Coll., purchased, 1905.

Koninckites oclusus, sp. nov.

Plate V, fig. 1.

TYPE. B.M., C. 10431b, ex Koken Coll. (" *Koninckites davidsonianus*", *partim*).

DIAGNOSIS. Platygyral, subleptogyral, perangustumbilicate *Koninckites*, differing from *K. davidsonianus* merely in the almost closed umbilicus.

REMARKS. This species, based on a single example, is included in *Koninckites* on account of its close resemblance to the forms above described, but in its small umbilicus it also shows affinity with *Clypeoceras* and, in fact, may be considered to be a transition to the form described below as *C. (K. ?) largisellatum* (Koken MS.), sp. nov., with the umbilicus quite closed and the periphery considerably sharpened. Another fragmentary specimen (C. 10432b) of possibly a new species of *Koninckites* was also included by Koken in his "*Aspidites*" *largisellatus*, but it appears to be a similar passage form. It differs from the species here described merely in greater whorl thickness and in the details of the auxiliaries.

HORIZON AND LOCALITIES. Lower Eo-trias, Lower Ceratite Limestone (Gyronitan). Salt Range.

SPECIMENS :

C. 10431b. Chideru, Salt Range, India.

Koken Coll., purchased, 1905.

Koninckites krafftii, Spath.

Fig. 43c, p. 152.

1909. *Meekoceras varaha*, Diener (in v. Krafft and Diener), p. 17, pl. ii, figs. 4a-d (lectotype), 2, 3, 5, 6 ; pl. xiv, figs. 7, 8 ; Diener, 1915a, p. 195 ; 1930, Spath, p. 28.

DIAGNOSIS. Platygyral, subleptogyral, angustumbilicate *Koninckites*. Sides flattened, nearly smooth, venter rounded to tabulate ; umbilical wall high, with sharp edge, except near aperture. Striæ of growth sometimes accentuated into indistinct sigmoidal folds. Suture-line ceratitic, with a row of irregular umbilical denticulations, but no distinct auxiliary lobe.

MEASUREMENTS :

Krafft and Diener, p. 18, No. iii	.	46	·52	·30	·11
„ „ „ No. iv	.	59	·53	·30	·12

REMARKS. The general similarity of this form to the more evolute *Prionolobus lilangensis* (v. Krafft) with essentially similar suture-line (see Pl. IV, fig. 4), on the one hand, and to the discoidal *Clypeoceras ensanum* (v. Krafft), on the other, shows how intimately related are these supposed genera. Diener directed attention to the impossibility of referring to the genus *Kingites* those forms of the present group in which the auxiliary lobe in the umbilical denticulations became clearly recognizable. But I cannot accept his comparison of the species now discussed to

the true *Meekoceras*, which are entirely different in proportions ; even the resemblance in the suture-lines is superficial.

"*Kingites*" *varaha*, Diener (1895, p. 52, pl. i, fig. 2), on account of its larger umbilicus (17% of the diameter), is closer to the form described above as *K. apertus*, and to certain *Paranorites*, than to the species here discussed.

HORIZON AND LOCALITIES. Lower Eo-trias, Gyronitan, "*Meekoceras* Beds". Himalayas.

SPECIMENS :

C. 28535-6. One mile north of Lilang, Spiti. (Collected and determined by A. v. Krafft, but doubtful.)

Presented Geol. Surv. India, 1926.

***Koninckites timorensis* (Wanner).**

1911, p. 185, pl. vi, figs. 2 (lectotype), 3, pl. vii ; figs. 5, 6 (*Meekoceras*) ; Welter, 1922, p. 129.

DIAGNOSIS. *Koninckites* like *K. krafftii*, but with more individualized first auxiliary lobe.

MEASUREMENTS :

Wanner, pl. vi, fig. 2	.	79	.	51	.	23	.	13
" " fig. 3	.	53	.	55	.	—	.	10

REMARKS. This species, judging by the literature, might not seem sufficiently distinct from *K. krafftii* to be given an independent name ; but the numerous Timor examples in the collection are certainly different from the two Himalayan "*Meekoceras varaha*", also in the Collection, determined by A. v. Krafft himself. The most obvious distinction seems to be the more marked umbilical rim of the Himalayan forms ; but I am not satisfied that Krafft was right in separating these two examples of "*M. varaha*" from his *M. lilangense*. In any case, the Timor forms, as Welter has already suggested, may also be compared to *Aspidites spitiensis*, v. Krafft (in v. Krafft and Diener, 1909, pl. iv, figs. 4, 5), and most of the specimens listed below are more involute than Wanner's type. The excentrumbilication is noticeable in most of the Timor examples, and there seems to be a fair uniformity of suture-line, but the auxiliaries are always much less developed than in *A. spitiensis*. In many of the less well-preserved Timor specimens the suture-line is not visible, and they are provisionally referred to the present species merely on account of their great involution.

There are also many unsorted young that are probably largely referable to the present species.

HORIZON AND LOCALITIES. Lower Eo-trias, Upper Flemingitan (*Meekoceras* Beds). Timor.

SPECIMENS :

C. 34024-43, 37321-39. Nifoekoko, Timor.

M. E. Walsh Coll., 1930.

C. 34005-23. Toeboelopo, Timor.

M. E. Walsh Coll., 1930.

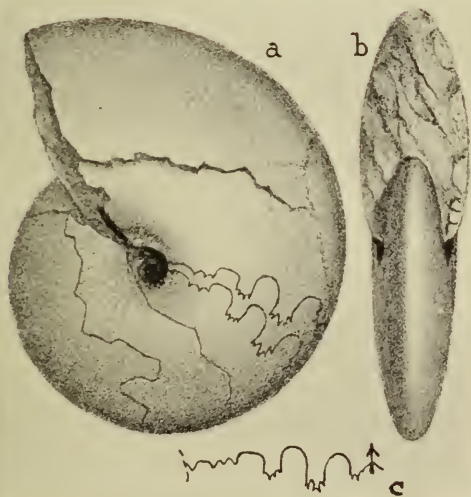


FIG. 45.—*a-c*, *Kingites lens*, Waagen. Lower Eo-trias. Salt Range.
(After Waagen, 1895, pl. xxvi, figs. 4*a*, *b*, *d*.)

Genus **KINGITES**, Waagen, 1895, p. 230.

GENOLECTOTYPE. *Kingites lens*, Waagen, 1895, p. 232, pl. xxvi, figs. 4*a-d* (here chosen).

DIAGNOSIS. Paranoritidæ with rather involute, discoidal shells, with rounded venter and deep, funnel-shaped umbilicus. Suture-line ceratitic, like that of *Koninckites*, but indentations more individualized.

DISTRIBUTION. Lower Eo-trias, Ceratite Marls. Salt Range.

REMARKS. This genus is here retained for those discoidal forms that, by their suture-lines and general appearance, resemble *Koninckites*, but in the deep, funnel-shaped umbilicus

are transitional to Proptychitidæ. Thus the compressed *Proptychites oldhamianus*, Waagen, with suture-line resembling that of *Kingites lens* rather than the suture-lines of the typical Proptychitids, as well as "*Meekoceras*" *tenuistriatum*, v. Krafft (in v. Krafft and Diener, 1909, p. 34, pl. iv, figs. 3a-e), and "*M.*" *solitarium*, v. Krafft (*ibid.*, p. 52, pl. iii, fig. 1), are passage forms from *Kingites* to *Proptychites*.

"*Kingites*" *varaha*, Diener (1895, p. 52, pl. i, figs. 2a-c), on account of its more open umbilicus, may be referable even to *Paranorites*, but the less compressed Himalayan forms identified by Diener (1897, p. 143, pl. vi, fig. 2, pl. vii, fig. 6) and v. Krafft and Diener (1909, p. 17) with the Ussuri species, previously renamed *Koninckites krafftii* (see *supra*, p. 155), have the small, excentric umbilicus of the *davidsonianus* group.

Since Waagen (p. 207) stated that *Meekoceras keyserlingi* "most probably" also formed part of his genus *Kingites*, this species clearly cannot be taken as the genolectotype, which must be chosen from among the Salt Range forms. The Siberian species described by Mojsisovics (1886) and referred to by Waagen can be distinguished at once from the true *Kingites* by their Arctoceratid lateral lobes.

The genus *Kingites* is not represented in the Collection.

Genus **CLYPEOCERAS**, J. P. Smith, 1913, p. 645.

(= *Aspidites*, Waagen, 1895, p. 215, preoccupied.) Diener, 1915a, p. 59; Strand, 1929, p. 6 ("*Aspiditella*"); Kutassy, 1933, p. 429.

GENOTYPE. *Aspidites superbus*, Waagen, 1915, p. 218, pl. xxiii, pl. xxiv, fig. 1.

DIAGNOSIS. Involute, discoidal Paranoritidæ, with narrowly rounded, almost acute, venters and very small umbilicus. Suture-line generally with more advanced lobes and saddles, especially auxiliaries, than in *Koninckites*.

DISTRIBUTION. Lower Eo-trias (Gyronitan and Flemingitan). Salt Range.

REMARKS. The genus *Clypeoceras* should be restricted to those large forms occurring in the *Hedenstræmia* Beds which correspond to the type-species, *C. superbum*; but it is doubtful whether forms like *C. ? largisellatum* (Koken) described below are correctly referred to this genus, whilst "*Aspidites*" *mutthianus*, v. Krafft (1909, p. 59, pl. xv, figs. 1, 2) and allies are

here included in the new genus *Pseudaspidites*. *Kingites*, which has been identified by v. Krafft (1909, p. 53) with the present genus, is taken to apply only to those earlier forms with deep, funnel-shaped umbilicus, which lead to certain Proptychitidæ, but *Kingites* may provisionally include also such forms as "*Aspidites*" *vidarbha*, Diener (1897, p. 139, pl. vii, fig. 8). On the other hand, "*Aspidites*" *crassus*, v. Krafft (in v. Krafft and Diener, 1909, p. 58, pl. vii, fig. 1), except in its more advanced suture-line, resembles *Koninckites* and *Kingites*, and like "*Aspidites*" *ensanus*, v. Krafft (in v. Krafft and Diener, 1909, p. 56, pl. v, figs. 3-7), is transitional between these two genera and *Clypeoceras*.

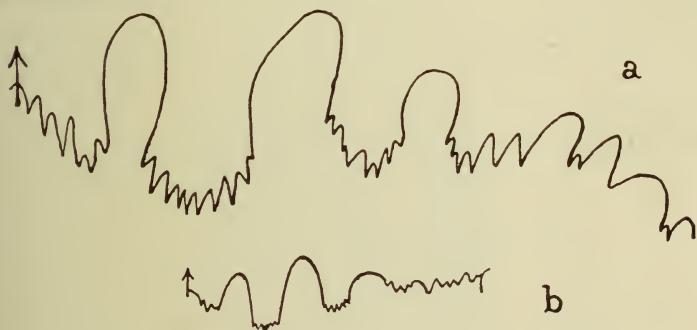


FIG. 46.—Suture-lines of *Clypeoceras*. a, *C. superbum* (Waagen). (After Waagen, 1895, pl. xxiv, fig. 1b [*"Aspidites"*].) b, *C. (Koninckites?) largisellatum* (Koken MS.), sp. nov. From holotype, no. C. 10432a. Lower Eo-trias. Salt Range.

***Clypeoceras* (*Koninckites* ?) *largisellatum* (Koken MS.), sp. nov.**

Plate VIII, figs. 3a, b.

TYPE. B.M., C. 10432a, ex Koken Coll. (*Aspidites largisellatus*, Koken MS.).

DIAGNOSIS. Platygyral, subleptogyral, perangustumbilicate *Clypeoceras*. Sides flattened, venter very narrowly arched, tending to sub-acute. Suture-line ceratitic, with a number of auxiliaries, but in general agreement with that of *Koninckites*.

REMARKS. It has already been mentioned that this form is probably at least as closely allied to the group of *Koninckites davidsonianus* (included in "*Aspidites*" already by Frech, 1905, p. 2) as to the later type of *Clypeoceras*, namely, *C. superbum*, from the *Hedenstræmia* Beds. On account of its small umbilicus,

however, and its sharpened periphery, the present species may be left in the genus to which its author had referred it. *Clypeoceras superbum* differs from the species here described merely in being less compressed (thickness = 24% of the diameter instead of 18%) and in having the second lateral saddle as well as the auxiliaries more advanced, at least at larger diameters. The holotype of *C. ? largisellatum*, however, at 70 mm. diameter shows already part of the body-chamber, and therefore in size also agrees more with *Koninckites* of the *davidsonianus* group than with the true *Clypeoceras*.

C. discum (Waagen) is less discoidal, less compressed and less involute than the present species, but has a comparable suture-line.

HORIZON AND LOCALITIES. Lower Eo-trias, Lower Ceratite limestone (Upper Gyronitan). Salt Range.

SPECIMENS :

C. 10432a. Chideru, Salt Range, Punjab, India.

Koken Coll., purchased, 1905.

***Clypeoceras ensanum* (v. Krafft).**

Plate XII, fig. 3.

1909. *Aspidites ensanus*, v. Krafft, in v. Krafft and Diener, p. 56, pl. v, figs. 6a-c (lectotype), 3-5, 7 ; pl. vi, fig. 1 ; pl. xiv, fig. 6.

DIAGNOSIS. Platygyral, subleptogyral, angustumbilicate *Clypeoceras*. Sides flattened, with sigmoidal striæ of growth or with indistinct folds. Umbilical wall low and rounded, venter narrowly tabulate. Suture-line (Pl. XII, fig. 3) ceratitic, with saddles more linguiform than in *C. (Koninckites ?) largisellatum*, but less club-shaped than in *C. superbum* (see figs. 46a, b, p. 159).

MEASUREMENTS :

Krafft and Diener, 1909, p. 56	21.3	.56	.19	?
" " pl. xi, fig. 6	33	.55	.20	.08
C. 28538	60	.55	.21	.10

REMARKS. This species resembles Waagen's "*Aspidites*" *discus* (1895, p. 228, pl. xxv, fig. 2a-c); but that species, as v. Krafft (in v. Krafft and Diener, p. 56) correctly stated, represents the inner whorls of one of the later and larger *Clypeoceras*, whilst *C. ensanum* is a small species. *C. spitiense*, v. Krafft sp. (in v. Krafft and Diener, 1909, p. 54, pl. iv, figs. 4, 5, pl. xvi, figs. 3-8), is still more involute, whilst *C. crassum*, v. Krafft sp. (*ibid.*, p. 58, pl. vi, fig. 4, pl. vii, fig. 1, pl. viii, fig. 1), is more

inflated. *Pseudaspidites muthianus*, v. Krafft sp., discussed below, has a much more complex suture-line.

Many of the Timor examples in the Collection (C. 34049-53, from Nifoekoko, and C. 34054-64 from Toeboelopo) belong to a form of *Clypeoceras*, differing from the species here described merely in the smaller umbilicus; but they are all small and imperfectly preserved. It is possible that at least the most involute of them are identical with *C. spitiense* (v. Krafft).

HORIZON AND LOCALITIES. Lower Eo-trias, Gyronitan ("Meekoceras" Beds). Himalayas.

SPECIMENS :

C. 28538. Lilinithi, Byans, Kumaon (detd. A. v. Krafft).

Presented Geol. Surv. India, 1926.

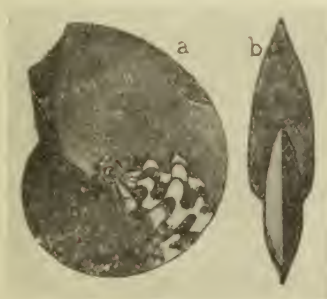


FIG. 47.—*Paraspidites præcursor* (Frech). Lower Eo-trias. Salt Range. (After Frech, 1905, pl. xxiv, fig. 4 = *Aspidites superbus*, mut. *præcursor*, Frech.)

Genus **PARASPIDITES**, nov.

GENOTYPE. *P. præcursor*, Frech, sp. = *Aspidites superbus*, Waagen, mut. *præcursor*, Frech, 1905, pl. xxiv, fig. 4.

DIAGNOSIS. Involute, discoidal Paranoritidæ, with oxynote venter and deep umbilicus. Suture-line with less developed auxiliaries than in *Clypeoceras*.

DISTRIBUTION. Lower Eo-trias (Upper Ceratite Marls), Flemingitan. Salt Range.

REMARKS. The genotype is so distinct from *Clypeoceras superbum* (Waagen) that generic separation is necessary. Frech considered that the species here described was merely an older and smaller mutation of the typical gigantic *Clypeoceras superbum*, but Koken (on a label) already had given the

former an independent specific name ("*Aspidites cultrijugatus*", Koken MS.). The presence of a high, vertical, umbilical wall, with sharp rim, and of an acute periphery, already at a small diameter, clearly indicates that *P. præcursor* cannot be attached to the genus *Clypeoceras*, in which, moreover, the auxiliary elements of the suture-line are much more developed. From v. Krafft's (1909, pl. xix, fig. 2) peripheral view of Waagen's holotype of *Clypeoceras superbum* it might be assumed that the young of *Clypeoceras* have an oxynote venter, but judging by the other known species of that genus, the periphery is rounded or even tabulate in the early stages.

Paraspidites præcursor (Frech).

Plate III, fig. 2.

1905, pl. xxiv, fig. 4 (holotype = *Aspidites superbus*, Waagen, mut. *præcursor*); Diener, 1915a, p. 60 (*A. superbus*, var. *præcursor*, Frech).

DIAGNOSIS. Platygyral, subleptogyral, subangustumbilicate *Paraspidites*. Sides smooth, bulging near umbilicus. Vertical umbilical wall with distinct rim; periphery oxynote. Suture-line as in *Clypeoceras superbum*, but with first saddle of auxiliary series already on umbilical edge.

REMARKS. This distinct form is represented by two examples (labelled "*Aspidites cultrijugatus*, Koken"), of which the larger, with dimensions 54·50·24·22, is still entirely septate. At the anterior end of the shell the umbilicus seems to open out (see Pl. III, fig. 2), so that it is improbable that the present oxynote form has any resemblance to the young of typical *Clypeoceras*. The similarly oxynote *Aspenites*, Hyatt and Smith (1905, p. 95), is distinguished by its different suture-line and closed umbilicus; also *Pseudaspenites*, gen. nov. (p. 230; for *Aspenites layeriformis*, Welter, 1922, p. 97, pl. i, figs. 6-8), with more open umbilicus, differs very considerably in suture-line from *Paraspidites*. The Albanian genus *Beatites*, Arthaber, with greater compression, and less well-defined umbilical edge than *Paraspidites*, seems to be distinguished by its goniatitic suture-lines, but may belong to the same stock as *Aspenites*.

It seems improbable that there is any direct genetic connection between *Paraspidites* and the earlier, acute, *Vishnuites*, Diener; or even to the family Otoceratidæ. The inclusion in Paranoritidæ, however, is based on the similarity in suture-line, and, pending the study of the development on well-preserved material, can only be regarded as provisional.

HORIZON AND LOCALITIES. Lower Eo-trias, Flemingitan. Salt Range.

SPECIMENS :

C. 10450a, b. "*Stachella* Beds," Virgal, Salt Range, Punjab.
Koken Coll., purchased, 1905.



FIG. 48.—*Pseudaspidites muthianus* (v. Krafft). Lower Eo-trias. Himalayas. (After v. Krafft and Diener, 1909, pl. vi, figs. 5a, b, reduced to $\frac{5}{7}$ linear.)

Genus **PSEUDASPIDITES**, nov.

GENOTYPE. *Aspidites muthianus*, v. Krafft, in v. Krafft and Diener, 1909, p. 59, pl. vi, figs. 5a, b (lectotype); pl. xv, figs. 1, 2.

DIAGNOSIS. Involute, discoidal, smooth Paranoritidæ with rounded or subtruncate venter. Suture-line subammonitic,

more subdivided than in *Koninckites* or *Clypeoceras*, and with sub-monophyllic saddles.

DISTRIBUTION.—Upper Eo-trias, Owenitan (*Hedenstræmia* [and *Meekoceras* ?] Beds). Himalayas; Idaho ?

REMARKS. The differences in the suture-lines of v. Krafft's three examples (possibly representing different forms) and the true "*Aspidites*" are important enough for generic separation. In the latter genus the saddles are still entire, whereas in *Pseudaspidites* the ceratitic subdivision of the lobes has encroached considerably on the saddles, and greater differentiation of the external lobe as well as of the auxiliaries has set in. In the families Hedenstræmidæ and Proptychitidæ, which have a common origin with the Paranoritidæ, sub-monophyllic saddles are often developed, also in the less closely related Flemingitids; but in the Ussuridæ, also of Owenitan age, one of the most advanced Lower Triassic stocks, this feature is brought to an extreme development. In its whorl-shape *Pseudaspidites* clearly resembles the Paranoritids. It is more probable that the slight folds shown in the (apparently new) species represented in v. Krafft's fig. 2 (pl. xv) indicate affinity with certain Proptychitids, but not with the stock here separated as *Subflemingites*, gen. nov.

The American form recently figured by J. P. Smith (1932, p. 64, pl. xxvii, figs. 1-7) as *Clypeoceras muthianum* (v. Krafft) may belong to the present genus, but I am not convinced of its "perfect agreement" with the Himalayan type.

Pseudaspidites is not represented in the collection.

E. Family PROPTYCHITIDÆ, Waagen, *emend.*

1895, p. 162 (as sub-family of Ptychitidæ); Spath, 1930, p. 39.

DIAGNOSIS. Discoidal, more-or-less involute, smooth or feebly ornamented ammonites with arched or sharpened venters and generally with subtrigonal whorl-section, which produces a deep umbilicus. Suture-lines ceratitic to subammonitic, tending to produce monophyllic saddles.

REMARKS. This family, like the Paranoritidæ, includes derivatives of the Ophiceratidæ, and has recently been discussed in my East Greenland memoir, where I criticized Waagen's grouping of the genus *Proptychites* in the same sub-family as the genera *Beyrichites*, *Ptychites* and *Sturia*. These, in my opinion, are referable to the three families Ceratitidæ,

Ptychitidæ and Cladiscitidæ, respectively. The Proptychitidæ, again, were not taken to be subordinate to the family Ptychitidæ. The Meso-triassic *Ptychites*, with its Arcestit inner whorls, is not directly descended from the Eo-triassic Proptychitidæ, although *Proptychitoides*, described below, and the Paranannitidæ, can be taken to be connecting links.

Waagen's second sub-family also, the Gymnitinæ, still listed by Arthaber (1911) as a sub-family of Ptychitidæ, has no connection with the Proptychitidæ, as is shown below. On the other hand, the genus *Pachyproptychites*, Diener, the creation of which was undoubtedly justified, is now also included in the present family.

Waagen divided his species of *Proptychites* into two sections: Nudi and Plicosi. Certain species of the first section, as has already been mentioned, might, perhaps, be referred to genera among the Paranoritidæ, which represent a parallel development, but without inflation; and *P. aberrans*, Waagen, though a doubtful form, probably is also generically separable from *Proptychites*. As regards the second section, *P. obliqueplicatus*, Waagen, unless very incorrectly drawn, must also be placed in a distinct genus (see *Eoptychites*, p. 177); but I have mentioned before (1930, p. 40) that a corresponding development of *Proptychitoides*, including *P. nopsai*, Spath (= *Proptychites obliqueplicatus*, Arthaber, non Waagen), on account of imperfect preservation, cannot yet be satisfactorily separated from the more typical forms of that genus, and may be provisionally referred to *Proptychitoides*.

Ussuriceras, Spath, described below, is an important link with the family Ussuridæ, suturally the most highly developed of all the Eo-triassic families.

The genus *Procarnites*, Arthaber, is only provisionally included in the present family, for it occupies an isolated position among the known Eo-triassic stocks. Its author had first compared at least some of his forms to *Hedenstrœmia*, and in 1911 he still included *Ussuria* in the same family (Carnitidæ). Diener (1915b, p. 30) correctly pointed out that, whilst *Procarnites* and *Hedenstrœmia* showed no similarity at all in the development of their suture-lines, even *Ussuria*, with identical adventitious elements, could not be genetically connected with *Procarnites*. That the Carnitidæ themselves, with the Upper Triassic *Carnites* and allies, are connected with the present genus cannot be seriously held, as mentioned already by Diener.

The resemblance between *Procarnites kokeni* and *Parapopanoceras*, to which *Procarnites kokeni* had first (Arthaber, 1908, p. 259, pl. xi, figs. 1, 2) been relegated, is also extremely distant; for apart from the obvious differences in the suture-lines, the young of *Procarnites* are compressed and evolute, not involute and globose.

On the other hand, *Procarnites* undoubtedly shows great resemblance to *Proptychitoides*, and it has already been mentioned that *Proptychitoides krafftii* (Arthaber) may easily be confused with specimens of *Procarnites* that do not well show the suture-lines. The differences in the lobes and saddles, of course, are striking, and of generic importance; but there is only a step from the irregular auxiliaries of forms like *Propt. krafftii* (see fig. 51c, p. 172) to the serial saddles in *Procarnites*. The development of adventitious elements in the median saddle of the external lobe of the latter genus is also only just indicated, and points to specialization in a direction different from that followed by the typical Proptychitids, on the one hand, and the Ussurids and Hedenstroemids on the other.

1. Sub-family PROPTYCHITINÆ.

DIAGNOSIS. Proptychitidæ with narrowly or broadly arched venters, but no sharpening of the periphery.

Genus **PROPTYCHITES**, Waagen, 1892, p. 379.

1915a, Diener, p. 231.

GENOTYPE. *Ceratites lawrencianus*, de Koninck, 1863, p. 14, pl. vi, fig. 3.

DIAGNOSIS. More-or-less involute, discoidal Proptychitidæ, with tendency to inflation, especially of the inner half of the whorl-sides, and consequently with a deep umbilicus. Venter arched, suture-line sub-ceratitic, more advanced than that of ancestral Opliceratids.

DISTRIBUTION. Lower Ceratite Limestone to Ceratite Sandstone; Salt Range. Upper Gyronitan and Flemingitan; Himalayas, Siberia (and California?). Gyronitan (?); East Greenland.

REMARKS. The discoidal forms of the type of *P. oldhamianus*, Waagen, seem to be close to true *Kingites* and *Koninckites*; but the typical inflation which led to the extreme genus *Proptychitoides* was developed in some forms before the stock

became abundant, at the time of the deposition of the Ceratite Limestone.

Whether the (presumably still later) forms of the group of *P. walcotti*, Hyatt and Smith (1905, p. 85, pl. xix), belong to the same genus as *P. lawrencianus* is uncertain. They have

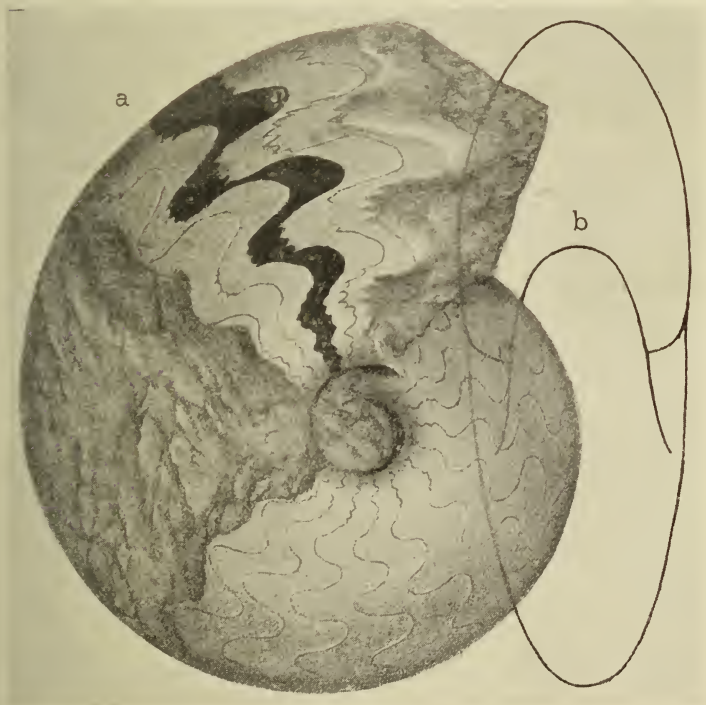


FIG. 49.—*Proptychites lawrencianus* (de Koninck). Lower Eo-trias ("Base of Ceratite Marls"). Salt Range. (After Waagen, 1895, pl. xviii, figs. 1a, b, reduced to $\frac{3}{4}$ linear.)

globose inner whorls, reminiscent of the doubtful *P. aberrans*, Waagen (1895, p. 179, pl. x, fig. 2), which may even yet turn out to be a Flemingitid. On the other hand, "*Meekoceras markhami*" (Diener, in v. Krafft and Diener, 1909, p. 20, pls. xi-xiii), with compressed *Kingites*-like inner whorls (and, in the sharpening of its periphery, suggesting transition to *Clypeoceras*), may well be left in *Proptychites*. Its suture-line (fig. 39b, p. 141) is

very close to that of Paranoritids, a parallel development with the family Proptychitidæ.

The genus is represented in the Collection merely by de Koninck's type of *P. latifimbriatus*, described below, and by two Himalayan specimens.

Proptychites latifimbriatus (de Koninck).

Plate II, figs. 1a, b.

1863. De Koninck, p. 13, pl. vii, fig. 2 (*Ceratites*); 1915a, Diener, p. 231.

DIAGNOSIS. Subplatygyral to platygyral, subleptogyral, subangustumbilicate *Proptychites*. Sides convex, with greatest whorl-thickness near rounded umbilical border; venter arched. Suture-line with L twice as long as E.

REMARKS. The holotype of the present species does not quite agree with the example figured by Waagen (1895, p. 170, pl. xviii, figs. 2a, b, c), for whereas the latter has dimensions 92-51-30-15, the corresponding figures for de Koninck's type are 90-48-32-20. The umbilicus is thus even wider in the type of *P. latifimbriatus* than it is in *P. lawrencianus* (de Koninck) or *P. ammonoides* (Waagen), in which two forms it amounts to 17% of the diameter, but it is as yet far narrower than the umbilicus of *P. magnumbilicatus* (Waagen), with 29% of the diameter. Since there is, however, agreement with Waagen's form in all other characters, the latter may well be left in de Koninck's species. It is important to note that the inner whorls of these typical species are more compressed than those of the Himalayan *P. typicus*, v. Krafft (in v. Krafft and Diener, 1909, p. 77, pl. xxi, fig. 2a).

The Albanian forms figured by Arthaber (1911) as *Proptychites latifimbriatus* are referred to below under *Proptychitoides*. Hyatt and Smith's Californian "*Proptychites*" *walcotti* (1905, pl. xix), with a curious resemblance to some of the Meekoceratids, discussed below, may not belong to the present genus.

HORIZON AND LOCALITIES. Lower Eo-trias, Upper Gyronitan (Lower Ceratite Marls or Limestone?). Salt Range.

SPECIMENS :

C. 21966. de Koninck's holotype, from the "*Productus* Limestone", Vurcha, Punjab.

Coll. by Dr. A. Fleming, ex Geol. Soc. Coll.

(No. 9386), presented, 1911.

Proptychites markhami Diener.Fig. 39*b*, p. 141.1897, p. 75, pl. vi, figs. 4-6; 1915*a*, p. 193 (*Meekoceras*).

DIAGNOSIS. Platygyral, subleptogyral, angustumbilicate *Proptychites*. Sides flat in the young, tending to become inflated in the umbilical region in the adult, with narrowing of whorl-section near the arched venter; umbilicus opening out at large diameters; wall rounded. Suture-line ceratitic, as in *Paranoritidæ*.

MEASUREMENTS :

v. Krafft and Diener, 1909, p. 21, pl.

	xii, fig. 2	.	163	·45	·28	·20
Ditto	Ditto	at	74	·53	·27	·11
„	„	at	27	·59	·26	·07

REMARKS. This species was first referred by its author to *Proptychites*; but in 1909, following v. Krafft, he grouped it with *Meekoceras*, since the species was “not provided with globose inner whorls”. There is, of course, no affinity with the true *Meekoceras*, of a later age, but it is debatable whether the present species may not be more appropriately referred to *Paranoritidæ*, *e.g.* to *Koninckites* or *Kingites*, with similar inner whorls and suture-lines, or to *Clypeoceras*, with sharpened periphery. On the whole, however, the resemblance to typical *Proptychites* from the Salt Range as well as the Himalayas is close enough to justify the retention of the species now discussed in *Proptychites*. It may be pointed out in this connexion that the inner whorls of de Koninck's *P. latifimbriatus* and its allies are more compressed than those of the Himalayan *Proptychites* described by v. Krafft.

HORIZON AND LOCALITIES. Lower Eo-trias, Gyronitan, “*Meekoceras* Beds”. Himalayas.

SPECIMENS :

C. 28534, Shalshal Cliff, Paikhanda, Kumaon. (“*Meekoceras noetlingi*, v. Krafft.”)

Presented Geol. Surv. India, 1926.

Proptychites typicus, v. Krafft.

1909, p. 77, pl. xix, figs. 4, 5; pl. xx, fig. 6; pl. xxi, figs. 2-4.

DIAGNOSIS. Platygyral, subpachygyral to subleptogyral, subangustumbilicate *Proptychites*. Whorl-sides gently convex,

smooth in the adult, with indistinct folds in the young; umbilical wall perpendicular, edge rounded; venter arched. Suture-line as in other species of *Proptychites*.

MEASUREMENTS :

v. Krafft and Diener, 1909, p. 77

	("stout variety")	74	·50	·32	·18
Ditto	Ditto at	35	·49	·37	·20
„	("compressed variety")	48·4	$\frac{H}{Th.} = 1·47$		

REMARKS. This form differs from *P. scheibleri*, Diener (1897, p. 79, pl. vi, fig. 3), chiefly in being less inflated and in having a more definite umbilical edge, but v. Krafft considered it possible that, on examination of more abundant material from the Salt Range, the species now discussed might turn out to be "very nearly allied to or even identical with" *P. lawrencianus* (de Koninck), Waagen. It is interesting to note that *P. scheibleri* comes from the shales immediately above the main layer of *Otoceras woodwardi*, and that in the Otoceratan age *Proptychites* thus was already separated from the Paranoritids.

HORIZON AND LOCALITIES. Lower Eo-trias, Gyronitan, "Meekoceras Beds". Himalayas.

SPECIMENS :

C. 28546. Jolinka Encamping Ground, Kati Yangti Valley, Byans, Kumaon. (Detd. A. v. Krafft.)

Presented Geol. Surv. India, 1926.

Genus **PACHYPROPTYCHITES**, Diener, 1916, p. 101.

GENOTYPE. *Proptychitès otoceratoides*, Diener, 1895a, p. 36, pl. iii, figs. 2a, b.

DIAGNOSIS. Involute, discoidal Proptychitidæ with narrowly rounded venter and flat or slightly concave sides, high umbilical rim and deep, funnel-shaped umbilicus. Suture-line with wide external lobe and pointed median saddle, as in Paranoritids.

DISTRIBUTION. Lower Eo-trias (Gyronitan or earlier ?). Ussuri, Siberia.

REMARKS. The reference of this genus to *Otoceratidæ*, with similar pronounced umbilical rim, is shown to be untenable by the suture-line, which is clearly that of the Paranoritidæ. The tendency to thicken the whorl in the umbilical region is indicated in a number of Ophiceratid offshoots, here grouped in Proptychitidæ; but none has anything like the infundibuliform

umbilicus of the present genus, the creation of which was undoubtedly justified.

Genus **PROPTYCHITOIDES**, Spath.

1930, p. 39.

GENOTYPE. *Proptychitoides decipiens*, Spath, 1930, p. 39 = *Proptychites latifimbriatus*, Arthaber, non de Koninck; 1911, p. 223, pl. xix, figs. 2a-c (lectotype).



FIG. 50.—*Pachyproptychites otoceratoides* (Diener). Lower Eo-trias. Ussuri, Siberia. (After Diener, 1895a, pl. iii, figs. 2a, b; reduced to $\frac{3}{4}$ linear.)

DIAGNOSIS. More-or-less involute, inflated Proptychitidæ, with narrowly rounded periphery and deep umbilicus. Suture-line subammonitic, with monophyllic saddles and high external lobe.

DISTRIBUTION. Upper Eo-trias, Columbitan. Albania.

REMARKS. Arthaber justly observed that the Albanian forms differed from the Indian typical *Proptychites* in the coarsely-denticulated lobes and the club-shaped, unsymmetrical, monophyllic saddles. One of the Albanian forms, wrongly identified with de Koninck's *P. latifimbriatus* (the holotype of which is

here figured, Pl. II, fig. 1), was characterized by Arthaber himself (p. 225) as "different from the Indian type", and it was therefore listed by Diener (1915a, p. 231) as "*Proptychites* sp. ind. aff. *latifimbriatus*". The latter author (1913, p. 121) also noticed that another of Arthaber's forms, identified with the doubtful Indian *P. obliqueplicatus*, Waagen, in any case

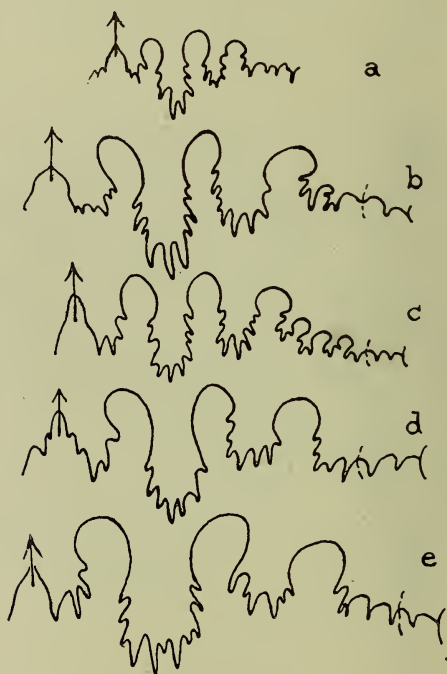


FIG. 51.—Suture-lines of *Proptychitoides*, Spath. a, b, *P. decipiens*, Spath (= *P. latifimbriatus*, Arthaber, non de Koninck). c, *P. krafftii* (Arthaber). d, *P. mahomedis* (Arthaber). e, *P. hakki* (Arthaber). Upper Eo-trias, Columbitan. Albania. (After Arthaber, 1911, pl. xix, figs. 1c, 2c, 3c; pl. xxii, figs. 3c, 1c.)

"differed in the shape of its transverse section". The stock here discussed is undoubtedly generically separable from *Proptychites*; and the costation also, inconspicuous or absent in the Indian types, is very pronounced in at least some examples of the genotype of *Proptychitoides*, at quite small diameters (under 20 mm.). "*Meekoceras*" *mahomedis* and "*M.*" *hakki*, Arthaber, are also included in the present genus. The latter species

was compared by its author to the Himalayan *Proptychites markhami*, Diener; the former was described as transitional and referable, according to individual judgment, either to *Proptychites* or to *Meekoceras*. Since, however, these two closely allied species were assigned to the two widely separated "phyla" of Tornocerata on the one hand, and Gephyrocerata on the other, the unfavourable opinion generally expressed on Arthaber's classification seems justified.

Proptychitoides decipiens, Spath.

Plate IV, figs. 2a, b.

1911. *Proptychites latifimbriatus* (de Koninck), Waagen; Arthaber, p. 223, pl. xix, figs. 1, 2.

1915. *Proptychites* sp. ind. aff. *latifimbriatus* (de Koninck); Diener (a), p. 231.

1930. *Proptychitoides decipiens*, Spath, p. 39.

DIAGNOSIS. Platygyral, subpachygyral, subangustumbilicate *Proptychitoides*. Sides flattened, whorl-section subtriangular, with narrowly arched venter and high perpendicular umbilical wall. Close, radial ribs, continuous across periphery. Suture-line with monophyllic saddles (fig. 51a, b, p. 172).

MEASUREMENTS:

C. 22755 (PL. IV, figs. 2a, b)	50	·55	·42	·22
Arthaber's example I	58	·53	·31	·21
„ „ II	79	·55	·40	·24

REMARKS. The discrepancies between Arthaber's figures and his measurements in the text are comprehensible to those who know the state of preservation of the ammonites in the Albanian Lower Trias. The six metatypes listed below vary also considerably in dimensions; and two examples with smaller umbilicus are transitional to the form described below as *P. krafftii* (Arthaber). The suture-line has been exposed in one specimen by grinding down the corroded surface, but it still shows the saddles even more monophyllic than in Arthaber's diagrammatic figures here reproduced (fig. 51, p. 172).

Proptychitoides arthaberi (Welter, 1922, p. 102, pl. clvi, figs. 1-4) is distinguished from the present species by its wider periphery, absence of distinct ribbing and less monophyllic saddle endings.

HORIZON AND LOCALITIES. Upper Eo-trias, Upper Owenitan. Këçira, Albania.

SPECIMENS :

C. 22753-5, 22758-60. Six metatypes.

Baron F. Nopcsa Coll., purchased, 1922.

Proptychitoides krafftii (Arthaber).

1911, p. 224, pl. xix, figs. 3a-c ; Diener, 1915a, p. 231.

DIAGNOSIS. Platygyral, subleptogyral, angustumbilicate *Proptychitoides*, with a smaller umbilicus and with auxiliary saddles of the suture-line more distinct than in *P. decipiens*, which it closely resembles (see fig. 51c, p. 172).

MEASUREMENTS :

Arthaber's example I	.	47	.	55	.	32	.	13
„ „ II	.	75	.	56	.	32	.	12

REMARKS. In its smaller umbilicus one of the examples (C. 22756), referred by Prof. Arthaber to the last species, is clearly closer to *P. krafftii* ; but two supposed metatypes of the latter species, determined by Prof. Arthaber himself, with the umbilicus considerably smaller and its rim less well defined, are merely badly preserved *Procarnites*. The suture-lines are not clearly shown in these two examples, but have a greater number of saddles than in the present genus.

HORIZON AND LOCALITIES. Upper Eo-trias, Upper Owenitan. Kçira, Albania.

SPECIMENS :

C. 22756. (Labelled "*Proptychites latifimbriatus*").

Baron F. Nopcsa Coll., purchased, 1922.

Proptychitoides trigonalis (Arthaber).

1911, p. 225, pl. xix, figs. 4a-c ; Diener, 1915a, p. 232.

DIAGNOSIS. Platygyral, subpachygyral, subangustumbilicate *Proptychitoides*. Whorl-section subtrigonal, with arched venter and high and steep umbilical wall. Suture-line with monophyllic saddles, as in other species of *Proptychitoides*.

MEASUREMENTS :

C. 22752	.	.	.	63	.	50	.	40 ?	.	23
Arthaber's figs. 4a, b	.	.	.	78	.	51	.	45	.	20

REMARKS. This species is clearly intermediate between *P. decipiens* and the highly inflated *P. bertisci* (Arthaber, 1911, p. 225, pl. xix, figs. 5a-c). Its author compared it to the Siberian

Pachyproptychites otoceratoides, Diener, above discussed (p. 171), but this form is considerably closer to the true *Proptychites* and to *Ussuriceras* than to the present genus. Of the three examples before the writer, two (C. 22752 and 22757) were included by Prof. Arthaber in *P. decipiens* (= "*Proptychites latifimbriatus*" on his labels), obviously in error, for this form has a much smaller umbilicus and a much more prominent edge. One of the examples shows fine *Monophyllites* striation on the inner lateral area, and on the outer portion ribs like those of *P. decipiens*.

HORIZON AND LOCALITIES. Upper Eo-trias, Upper Owenitan. Kçira, Albania.

SPECIMENS :

C. 22752, 22757, 22763 (the last labelled "*Proptychites* juv.(?)").
Baron F. Nopcsa Coll., purchased, 1922.

***Proptychitoides mahomedis* (Arthaber).**

1911. *Meekoceras mahomedis*, Arthaber, p. 248, pl. xxii, figs. 3a-c ("*M. mahomedis*").

1915. *Proptychites mahomedis* (Arthaber); Diener (a), p. 232.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Proptychitoides*. Whorl-section compressed, with rounded sides and arched venter; with steep umbilical wall and indistinct folds on outer whorl. Suture-line as in other *Proptychitoides* (see fig. 51d, p. 172).

MEASUREMENTS :

Arthaber's example	I	.	90	.	·44	.	·31	.	·31
"	"		II	.	105	.	·48	.	·31
									·27

REMARKS. The close affinity of the present species with the other forms of the genus *Proptychitoides* was recognized by Diener; even Arthaber stated that it was only the difference in the auxiliaries that suggested reference to the genus *Meekoceras*. The three species of *Proptychitoides* previously described differ from *P. mahomedis* in their more trigonal whorl-shape, which also characterizes *Proptychitoides* (?) *nopcsai*, Spath (= *Proptychites obliqueplicatus*, Arthaber, non Waagen), with somewhat similar obscure folds on the outer whorl. Two of the examples in the Collection are poorly preserved, and the third has a more compressed whorl-section, without folds, but with a low umbilical rim, resembling that of *Monophyllites*; so that it may not even belong to the present group, although it is said to be one of Prof. Arthaber's metatypes of "*Meekoceras mahomedis*".

The comparison, by its author, of the present species with the doubtful immature Flemingitid (?) "*Meekoceras*" *rota*, Waagen, and with *Paranorites pulchrus* (Waagen), is not apt; nor are *Eoptychites* (?) *plicatus* (Waagen) and *Ussuriceras acutisellatum* (Diener) very close.

HORIZON AND LOCALITIES. Upper Eo-trias, Upper Owenitan. Kçira, Albania.

SPECIMENS :

C. 23088-9, 22866. Baron F. Nopcsa Coll., purchased, 1922.

Proptychitoides hakki (Arthaber).

1911. *Meekoceras hakki*, Arthaber, p. 247, pl. xxii, figs. 1a-c, 2.

1915. *Meekoceras hakki*, Arthaber; Diener (a), p. 192.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Proptychitoides*. Sides flattened; venter narrowly rounded, especially in the young; umbilical edge rounded, wall perpendicular. Suture-line as in other *Proptychitoides* (see fig. 51e, p. 172).

MEASUREMENTS :

Arthaber's example I	.	153	.	·49	.	·30	.	·23
„ „ II	.	178	.	·48	.	·28	.	·21

REMARKS. This species was left in *Meekoceras* even by Diener, who correctly referred Arthaber's "*Meekoceras*" *mahomedis* to the genus "*Proptychites*"; but there can be no doubt that the present form has no affinity whatever with the true *Meekoceras*, as here restricted. The only example in the collection, of 170 mm. diameter, is poorly preserved, and its suture-line is weathered; but the umbilical rim, though crushed, is distinctly rounded as in the other species of *Proptychitoides*.

Arthaber stated that "*Meekoceras*" *hakki*, the largest form in the Kçira fauna, could be compared only with the largest species of the Himalayan "*Meekoceras*" Beds, namely, *Proptychites markhami*, Diener. It is important to note that, as Arthaber points out, the latter form increases in whorl-thickness with age, whereas the Kçira species becomes more discoidal.

HORIZON AND LOCALITIES. Upper Eo-trias, Upper Owenitan. Kçira, Albania.

SPECIMENS :

C. 22865. Baron F. Nopcsa Coll., purchased, 1922.

Proptychitoides arthaberi (Welter).

1922, p. 102, pl. clvi, figs. 1-4 (*Proptychites*).

DIAGNOSIS. *Proptychitoides* like *P. decipiens*, but with numerous whorls and more rounded umbilical border. With less trigonal whorl-section than *P. trigonalis*.

MEASUREMENTS :

Holotype	.	.	.	49	.	47	.	39	.	20
C. 33748	.	.	.	51	.	48	.	37	.	25

REMARKS. When separating the Timor form from its Albanian allies, Welter pointed to a slight difference in the suture-line, caused by the less distinctly rounded saddle-endings in the former. This difference does not seem to hold, however, judging by the only example in the Collection of which the suture-line could be exposed; and the differences in coiling and whorl-shape are also negligible. On the other hand, the ribbing is less distinct in the well-preserved Timor material, confined to the sides, and shows much more resemblance to the striate *Monophyllites* ornamentation than does the ribbing of the Albanian forms.

HORIZON AND LOCALITIES. Upper Eo-trias (beds of which the constituents have a black manganese coating). Timor.

SPECIMENS :

C. 33748-9. Nifoekoko, Timor. *M. E. Walsh Coll.*, 1930.

Genus **EOPTYCHITES**, Spath.

1930, pp. 40, 89.

GENOTYPE. *Proptychites obliqueplicatus*, Waagen, 1895, p. 183, pl. xvii, figs. 3a, b.

DIAGNOSIS. More-or-less involute, disocidal, somewhat inflated Proptychitidæ with rursiradiate, bifurcating, blunt, costæ and arched venter. Suture-line, so far as known, like that of other Proptychitids or Paranoritids.

DISTRIBUTION. Upper Flemingitan, Ceratite Sandstone. Salt Range.

REMARKS. Waagen justly observed (p. 184) that the holotype of *P. obliqueplicatus* (one of the present genus), with "division of each rib into two towards the external side", could not be compared to any form that had been described. He stated that "there might, perhaps, exist a certain affinity between this species and *Proptychites khoorensis*, Waagen, but that more extensive and better materials were required to judge

on the case" (p. 164). Unfortunately, *Eoptychites obliqueplicatus* has not again been recorded by other observers. Arthaber's Albanian form, wrongly compared to Waagen's species, is discussed above (pp. 172 and 175) under *Proptychitoides*; Diener's Himalayan *Proptychites* sp. ind. ex aff. *obliqueplicato*, Waagen (1897, p. 81, pl. xvii, figs. 3a-c), is undoubtedly different, as Diener himself clearly recognized, and it may be renamed *Eoptychites? evolutus*, nom. nov. Its ribbing is radial, and its umbilicus, with high, perpendicular wall,

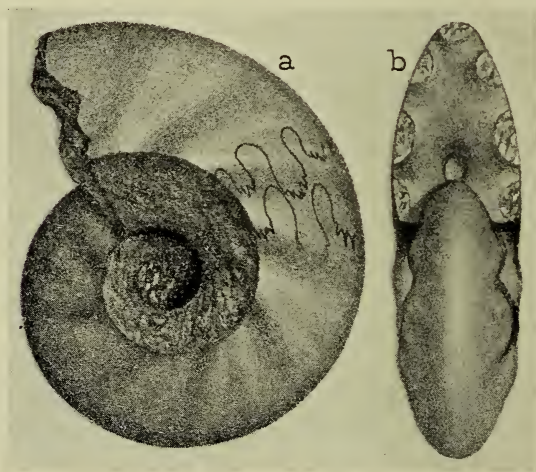


FIG. 52.—*Eoptychites obliqueplicatus* (Waagen). Lower Eo-trias, "Ceratite Sandstone". Salt Range. (After Waagen, 1895, pl. xvii, figs. 3a, b.)

is unusually large for a *Proptychitid*; but its suture-line shows resemblance to that of *Proptychites khoorensis*, above referred to, one of the forms which is transitional to *Kingites*. The inclusion of the Himalayan form in *Eoptychites*, however, must remain provisional.

Whether *Proptychites undatus*, *P. plicatus*, Waagen (1895, pp. 180, 182, pl. xxiv, figs. 4 and 3), and the new Himalayan and Timor forms, compared by v. Krafft and Diener (1909, p. 171, pl. xxviii, figs. 2a-c) and by Welter (1922, p. 101, pl. clvii, figs. 4-7) to *P. undatus*, belong to the present genus, must remain undecided until the genotype is more completely known.

Genus **USSURICERAS**, Spath.

1930, p. 40.

GENOTYPE. *Proptychites acutisellatus*, Diener, 1895a, p. 33, pl. ii, fig. 3.

DIAGNOSIS. Discoidal, involute Proptychitidæ, with flattened whorl-sides, arched venter, and high umbilical wall; traces of blunt, distant, recti-costæ. Suture-line subammonitic, with high, linguiform saddles.

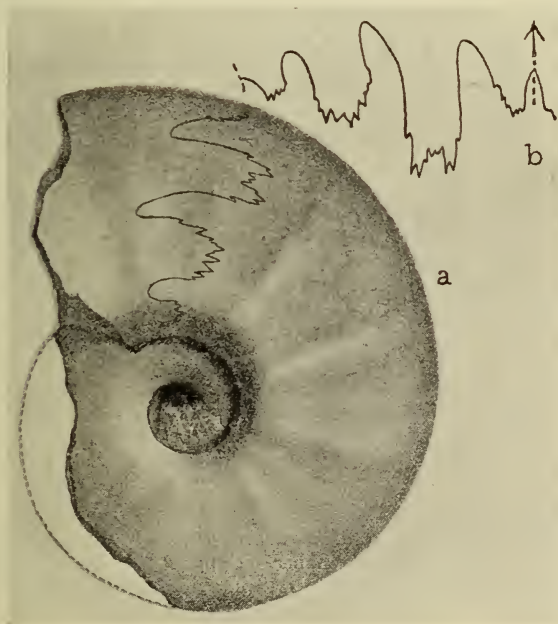


FIG. 53.—*Ussuriceras acutisellatum* (Diener). Lower Eo-trias. Ussuri, Siberia. (After Diener, 1895a, pl. ii, figs. 3a, b.)

DISTRIBUTION. Lower Eo-trias (Flemingitan ?). Ussuri.

REMARKS. The restriction of *Proptychites* to the group of *P. lawrencianus*, and the separation from it of such genera as *Eoptychites* or *Pachyproptychites*, make it desirable to keep the present genus apart from all the other stocks of the family Proptychitidæ, especially in view of its very distinct suture-line, indicating that Ussuridæ probably have resulted from specialization of a Paranoritid stock, closely allied to Proptychitids.

Proptychites hiemalis, Diener (1895a, p. 34, pl. ii, figs. 2, 4), the suture-line of which shows only a slight advance compared with that of *P. markhami*, Diener (see v. Krafft and Diener, 1909, pl. xiii, fig. 5), may be considered as a connecting link between the present genus and the typical *Proptychites*, but suggests that Monophyllitidæ have also sprung from the same root-stock.

Diener already had stated that none of Waagen's Indian "Plicosi" (= *Eoptychites*, gen. nov.) had a suture-line similar to that of the genotype of *Ussuriceras*.

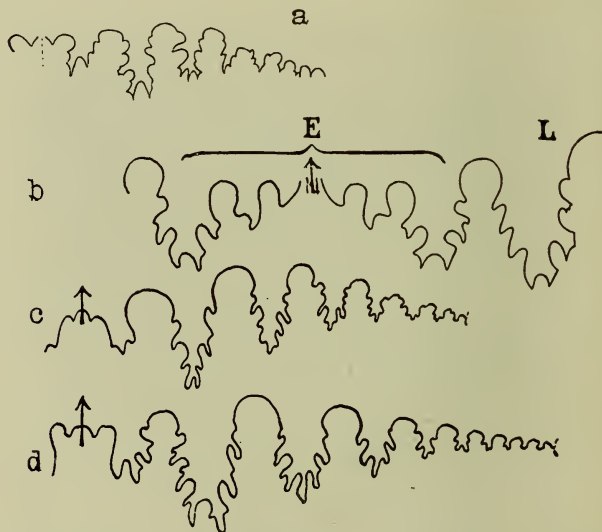


FIG. 54.—Suture-lines of *Procarnites*. a, b, *P. kokeni*, Arthaber. c, d, *P. skanderbegis*, Arthaber. Upper Eo-trias, Columbitan. Albania. (After Arthaber, 1911, pl. xviii, figs. 3, 6c, 7c [a, c, d] and text-fig. 8g, p. 212 [b].) All enlarged $\times 2$.

INCERTÆ SEDIS.

? Genus **PROCARNITES**, Arthaber, 1911, p. 212.

GENOTYPE. *Parapopanoceras kokeni*, Arthaber, 1908, p. 259, pl. xi, figs. 1, 2.

DIAGNOSIS. Discoidal, involute Proptychitidæ? with increased number of sutural elements.

DISTRIBUTION. Upper Eo-trias, *Subcolumbites*, Beds. Albania.

REMARKS. To the two species described by Arthaber is now added a third, based on two metatypes of this author's *Hedenstræmia* sp. (1908 = *Procarnites kokeni*, var., of 1911). The

oxynote periphery of this form is another point of convergence towards the family Hedenstrœmidæ.

Procarnites kokeni (Arthaber).

Plate III, fig. 1.

1908, p. 259, pl. xi, figs. 1, 2 (*Parapopanoceras*); 1911, p. 215, pl. xvii, figs. 16, 17; pl. xviii, figs. 1-5; Diener, 1915*a*, p. 228; 1915*b*, p. 29.

DIAGNOSIS. Platygyral, subleptogyral, angustumbilicate *Procarnites*. Sides flat, venter narrowly arched, tending to acute, umbilicus small and deep; falcoid striation on test. Suture-line with about ten megaphyllic saddles and ammonitic lobes; median saddle in external lobe tending to subdivide.



FIG. 55.—*Procarnites kokeni*, Arthaber. Upper Eo-trias, Columbitan. Albania. Variety with unusually broad ventral area. (After Arthaber, 1911, pl. xvii, figs. 16*a*, *b*.)

MEASUREMENTS :

Holotype (1908, pl. xi, fig. 1)	.	33	·50	·33	·19
Arthaber (1911, pl. xviii, fig. 4)	.	82	·52	·22	·12

REMARKS. The young of this species are comparatively inflated, and almost impossible to distinguish from immature examples of the form next described. One of the immature examples figured by Arthaber and here reproduced (fig. 55) shows an unusually broad venter, and probably represents a variety. On the other hand, in larger specimens the ventral area becomes almost acute, and there is then great resemblance to the form discussed below (p. 183) as *P. acutus*, nom. nov.

(= *Procarnites kokeni*, Arthaber, var.). Unfortunately the numerous examples of *Procarnites* in the Collection are all imperfectly preserved, and the identification of many of the doubtful immature examples, accepted on Arthaber's authority, seems unsafe. Moreover, it has already been mentioned that two specimens of what the writer would include in the present genus, if not necessarily in *P. kokeni*, were received as metatypes of Prof. Arthaber's "*Proptychites krafftii*".

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan. Kçira, Albania.

SPECIMENS :

C. 22700-05, 22706-24, 22761-2.

Baron F. Nopcsa Coll., purchased, 1922.

***Procarnites skanderbegis*, Arthaber.**

1911, p. 216, pl. xviii, figs. 6, 7 ; Diener, 1915a, p. 228 ; 1915b, p. 30.

DIAGNOSIS. Platygyral, subpachygyral, angustumbilicate *Procarnites*. Sides convex, inflated at middle and with deep umbilicus ; narrowly arched venter ; falcoid subcostation on test. Suture-line similar to last species, but with median saddle of external lobe less divided (see figs. 54c, d, p. 180).

MEASUREMENTS :

Holotype (Arthaber, pl. ii, fig. 7)	.	83	·54	·36	·10
Paratype (" " " 6)	.	55	—	·30	—

REMARKS. The inflation of the whorls at larger diameters seems sufficient to distinguish the present species from the last, but it will be seen that at 55 mm. diameter the thickness is only 30%, as against 33% in *P. kokeni* at 33 mm. Since all the specimens available for examination are of medium size, and since preservation of the details in the suture-lines (and of the umbilicus and its edges) is too imperfect, the identification of most of the specimens listed below (received as Prof. Arthaber's metatypes) must remain uncertain.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ? . Albania ; Timor.

SPECIMENS :

C. 22694-9. Kçira, Albania.

Baron F. Nopcsa Coll., purchased, 1922.

C. 34116-7. Nifoekoko, Timor (*Albanites* Bed).

M. E. Walsh Coll., 1930.

Procarnites acutus, nom. nov.

Plate V, figs. 4a, b.

1908. *Hedenstrœmia* sp., p. 284, pl. iii, fig. 2.1911. *Procarnites kokeni*, Arthaber, var., p. 216.1915. *Procarnites kokeni*, Arthaber, var.; Diener (a), p. 228.1915. *Procarnites kokeni*, Arthaber, var.; Diener (b), p. 30.

DIAGNOSIS. *Procarnites* resembling *P. kokeni*, but with acute periphery.

MEASUREMENTS :

C. 22725 (Pl. V, fig. 4). . 110 ? (100) .56 .20 ? .07

REMARKS. Arthaber stated that the differences between the present form and *P. kokeni* were confined to the shape of the ventral area and the formation of the suture-line. Even at 50 mm. diameter his example showed an oxynote venter, and the holotype here figured seems to be similar throughout, though crushed and corroded. A second specimen, on the other hand, at the same diameter (about 110 mm.) is still merely fastigate or sharpened, without being oxynote, and may thus be considered to be transitional to *P. kokeni*. The differences insisted on by Arthaber in the median saddles of the external lobe are also difficult to see, since in the preparation of the poorly preserved Albanian material the finer details are generally lost. In the second specimen, however, the median saddle seems to be wider than in the holotype.

P. skanderbegis, Arthaber, is easily distinguishable on account of its inflated whorl-section; and the *Hedenstrœmidæ*, with different suture-lines, are not close enough to the present species to give rise to confusion.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?. Kçira, Albania.

SPECIMENS :

C. 22725, 22882. Baron F. Nopcsa Coll., purchased, 1922.
(Two metatypes of *Procarnites kokeni*, var., Arthaber.)

Sub-family OWENITINÆ.

DIAGNOSIS. Lenticular to oxynote developments of Proptychitidæ, parallel with Paranannitids (*Isculitoides*) and with similar globose, constricted young, but distinguished by the suture-lines, while acquiring numerous (simple) elements.

REMARKS. Hyatt and Smith attached *Owenites*, the typical representative of this sub-family, to Ptychitidæ, as a descendant of “*Nannites*”; whilst Frech (1908, p. 491) listed it as a sub-genus of “*Popanoceras*”. Both views are comprehensible, since these stocks are closely related and there is great resemblance between *Owenites* and *Proptychites*; but it seems preferable to keep *Owenites* entirely separate, especially since the group now named *Parowenites*, nov., with goniatic suture-line, and radial ribbing, indicates specialization of Owenitids in several directions, and not merely in the development of a keel.

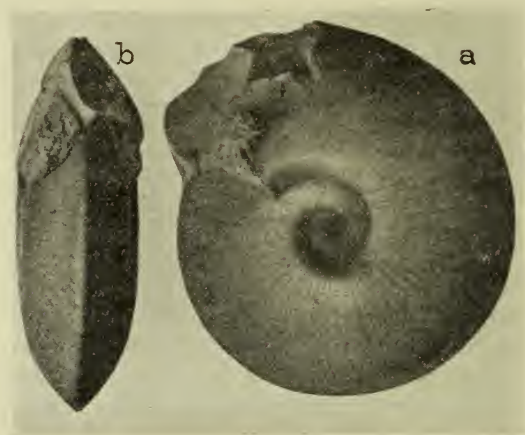


FIG. 56.—*Owenites egrediens*, Welter. Lower Trias. Bihati, Timor.
(After Welter, 1922, pl. clxviii, figs. 22, 23.)

Genus OWENITES, Hyatt and Smith.

1905, p. 82.

GENOTYPE. *O. kœneni*, Hyatt and Smith, 1905, p. 83, pl. x, figs. 1-22.

DIAGNOSIS. Lenticular, involute, smooth Owenitinae, tending to become oxycones. Ceratitic suture-line, with numerous lobes and saddles.

DISTRIBUTION. Upper Eo-trias, Owenitan (= Meekoceratan). California.

REMARKS. Hyatt and Smith recorded the occurrence, in the *Meekoceras* Beds of the Inyo Range, of several unnamed species of *Owenites*, besides *O. kœneni*, described below. The Timor

O. egrediens, Welter (1922, p. 151, pl. xiv, figs. 22–26), differs only in proportions and suture-line, but the same author's *Owenites simplex* (1922, p. 153, pl. xv, figs. 1–7) is here separated generically on account of its goniatic suture-line and distinct ribbing.

***Owenites kœneni*, Hyatt and Smith.**

1905, p. 83, pl. x, figs. 1–22; Diener, 1915a, p. 214; Welter, 1922, p. 152.

DIAGNOSIS. Platygyral, substenogyral, angustumbilicate *Owenites*, with contracting body-chamber. Sides gently convex,

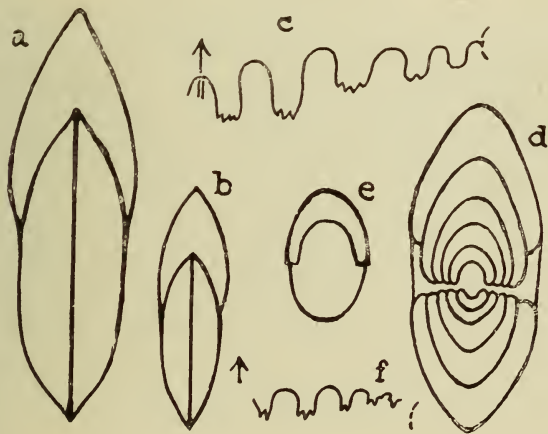


FIG. 57.—a–c, *Owenites kœneni*, Hyatt and Smith. Lower Trias. Inyo Range, California. Outline peripheral views of two examples and suture-line (enlarged $\times 3$) of holotype (adapted from Hyatt and Smith, 1905, pl. x, figs. 6, 8, 4). d–f, *O. egrediens*, Welter. Lower Trias. Bihati, Timor. Transverse sections and suture-line of three examples. (After Welter, 1922, text-figs. 14 and 18, p. 152, and pl. clxviii, fig. 24.)

smooth, with low, concave, umbilical wall. Periphery rounded to acute in adult. Suture-line with ceratitic lateral lobes and varying number of irregular, auxiliary elements.

MEASUREMENTS :

Holotype (Hyatt and Smith,

figs. 1, 2)	.	.	.	32	·50	·27	·09
C. 21865	.	.	.	43 (35)	·43	·29	·13

REMARKS. Hyatt and Smith mentioned that the umbilicus grew wider with age—a feature that is well seen in the example (C. 21865) above listed. This is, therefore, not a distinction from *O. egrediens* (see fig. 56), as Welter stated; but apart from the differences in the suture-line, in its more rounded whorl-shape, the Timor form is still closer to certain Paranannitids.

The two specimens in the Museum Collection are not identical, nor do two more examples in Dr. Trechmann's collection altogether agree in their dimensions. It is possible that, as Hyatt and Smith mentioned, there are several unnamed species, but it does not seem necessary to establish even varieties in what is obviously a very homogeneous group.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan (= Meekoceratan). California.

SPECIMENS :

C. 21864-5. Union Wash, Inyo Mountains.

Presented Dr. C. T. Trechmann (ex J. Perrin Smith Coll.).

Owenites egrediens, Welter.

Figs. 56, 57d-f.

1922, p. 151, pl. clxviii, figs. 22-3 (lectotype), 24-26; 1933, Kutassy, p. 606.

DIAGNOSIS. Like *O. kœneni*, but with uncoiling body-chamber and excentric umbilicus, also different suture-line. (Compare figs. 57c and f, p. 185.)

MEASUREMENTS :

Lectotype	.	.	50	.	·40	.	·34	.	·24
C. 33949	.	.	47	.	·43	.	·31	.	·22

REMARKS. There are ten well-preserved examples of this species, showing the various growth-stages illustrated by Welter. In some the umbilical rim is flared, as in *Otoceras*, and the whorl-section is galeate; in others the notching of the keel is that characteristic of the Callovian genus *Chamousetia*, and also a descendant of a cadicone stock. It is obvious, however, that they all belong to the same species, since they are connected by transitions with the examples agreeing with the lectotype.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan (= Meekoceratan); Timor. Also *Anasibirites* Beds; Timor (rare).

SPECIMENS :

C. 33949-58, 37183-5. Toeboelopo, Timor.

M. E. Walsh Coll., 1930.

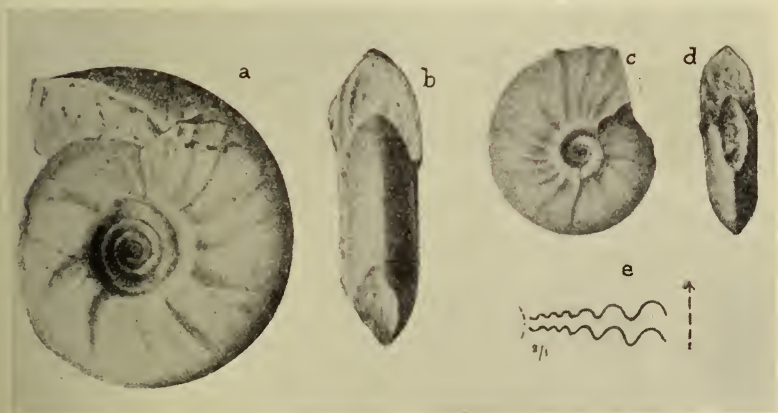
Genus **PAROWENITES**, nov.GENOTYPE. *Owenites simplex*, Welter, 1922, p. 153, pl. clxix, figs. 1, 2 (lectotype), 3-8.DIAGNOSIS. Rather involute, lenticular Owenitidæ, like *Owenites*, but with entire (goniatitic) suture-line and sigmoidal ribs.

FIG. 58.—*Parowenites simplex* (Welter). Side- and peripheral views of lectotype (*a*, *b*) and a paratype (*c*, *d*), with part of suture-line (enlarged $\times 2$) of the latter. Lower Trias. Bihati, Timor. (After Welter, 1922, pl. clxix, figs. 1-5.)

DISTRIBUTION. Upper Eo-trias, Owenitan (=Meekoceratan). Timor.

REMARKS. Welter did not favour the creation of a new genus for this "primitive" group, and since we have left in *Juvenites* some forms with goniatitic, and others with ceratitic, suture-lines, generic separation of *Parowenites* from *Owenites* may seem unnecessary. On the other hand, the differences in the proportions of the various elements (and in their arrangement) are considerable (compare figs. 57*c* and 58*e*), and concentricumbilication as well as the presence of distinct ribbing further distinguish the present forms from the true *Owenites*. A

separate name, then, is indeed advisable. Were it possible to prove that a small compressed form in the collection, C. 33961 (unfortunately too incompletely known to be described), belonged to the same group as *O. simplex*, then generic separation would be seen to be still further justified.

F. Family PARANANNITIDÆ, Spath.

1930, p. 85.

DIAGNOSIS. More-or-less globular Ammonites with depressed whorl-section, at least in young; often constricted, and with simple (goniatitic or ceratitic) suture-lines.

REMARKS. The genera *Paranannites* and *Juvenites* are taken to be offshoots of a possible primitive Proptychitid stock, and they cannot be regarded as Nannitids, since the true *Nannites*, of Carnian age, is merely a heterochronous homœomorph, *i. e.* a reduced development of some other branch (*Ptychitidæ*?). But *Arnautoceltites*, Diener, and the similar, dwarfed, *Paragoceras*, might perhaps have to be referred to the sub-family Columbitinæ.

A specimen (C. 37186) from the manganese-bearing *Albanites* Beds of Timor is transitional between *Subcolumbites* and *Arnautoceltites*. Since this unique example does not show a suture-line, it is not described separately, but it is almost certainly a new species. Welter's "*Prenkites*" *sundaicus* (1922, p. 150, pl. clxviii, figs. 18-21) is larger and more depressed, and does not seem to show the peculiar two- or three-fold constrictions that characterize the outer whorl of the specimen here discussed, but in *Prenkites timorensis* (see fig. 62*d, e*), the folds in between the constrictions are much more pronounced. The example is of importance, since it shows the close affinity between *Arnautoceltites* and the sub-family Columbitinæ.

Both *Arnautoceltites* and *Juvenites*, however, include forms with goniatitic suture-lines ("*Celtites*" *arnauticus*, Arthaber, and *Juvenites krafftii*, Smith), as well as those with ceratitic lateral lobes ("*Paranannites*" *mediterraneus*, Arthaber, and "*Thermalites*" *thermarum*, Smith). *Paranannites*, the earliest form, is closely allied to the reduced *Juvenites*; probably also to *Isculitoides*, which is considered to be merely a homœomorph of the true Upper Triassic *Isculites* of the family Haloritidæ. It was grouped by Arthaber with *Columbites*, in the family Tropitidæ, and it has already been mentioned that *Isculitoides*

is somewhat transitional between the Columbbitidæ and Paranannitidæ, so that in spite of the resemblance in the suture-lines, *Isculitoides* cannot be definitely attached to the ancestral *Paranannites*.

Prosphingites was classed by Hyatt and Smith with Popanoceratidæ; but, whilst there is no connection with the Permian *Popanoceras*, the Lower Anisian *Parapopanoceras*, Haug, which

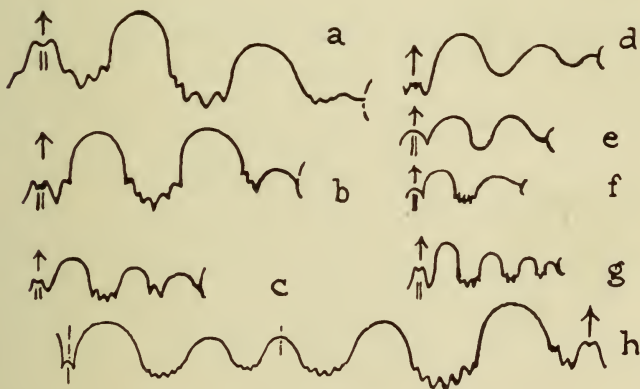


FIG. 59.—Suture-lines of *a, h*, *Paranannites aspenensis*, Hyatt and Smith. Lower Trias. Aspen Ridge, Idaho (enlarged $\times 4$). *b, c*, *Isculitoides originis* (Arthaber). Lower Trias. Albania (enlarged $\times 5$ and $\times 2$ respectively). *d*, *Juvenites ? dieneri* (Hyatt and Smith). Lower Trias. Inyo Range, California (enlarged $\times 2$). *e*, Gen. nov. ("*Styrites*") *lilangensis* (non Diener), Arthaber. Lower Trias. Albania (enlarged $\times 3$). *f*, *Arnautoceltites mediterraneus* (Arthaber). Lower Trias. Albania (enlarged $\times 2$). *g*, *Prosphingites ali*, Arthaber. Lower Trias. Albania (enlarged $\times 3$). [After Hyatt and Smith, 1905, pl. vii, fig. 13 (*d*) and pl. lxxiii, figs. 3 (*a*) and 6 (*h*); and Arthaber, 1911, pl. xviii, fig. 8c (*f*); pl. xxii, fig. 6c (*g*); pl. xxiii, fig. 1c (*b*), 6c (*c*), 12c (*e*).]

has some resemblance to *Prosphingites*, is already much closer to *Megaphyllites* and other later developments to be dealt with in the next part. Arthaber included *Prosphingites* in Sphingitidæ, but this family must be restricted to those evolute offshoots of the Arcestidæ, for which the genus *Sphingites* was first created. The resemblance of *Prosphingites* to *Paranannites* in suture-line, and to *Juvenites* in whorl-shape and irregular folds, seems to justify its inclusion in the present family.

1. Sub-family PARANANNITINÆ, nov.

DIAGNOSIS. Paranannitidæ with broadly arched venters, no tendency to carination, and generally more than one lateral lobe.

Genus PARANANNITES, Hyatt and Smith.

1905, p. 80 ; Diener, 1915*a*, p. 216.

GENOTYPE. *P. aspenensis*, Hyatt and Smith, 1905, p. 81, pl. viii, figs. 1-15, pl. lxxiii, figs. 1-30.

DIAGNOSIS. Rather involute, subglobose, laterally compressed dwarf Paranannitinæ, with arched venter ; at first smooth, later with irregular folds. Suture-line ceratitic.

DISTRIBUTION. Upper Eo-trias, Owenitan.

REMARKS. The *Ptychites*-like folds seen in some of the larger examples apparently correspond to the constrictions and ridges found in *Juvenites* and *Prosphingites*, and are most conspicuous on the broadly rounded ventral area. There is resemblance to certain Arctoceratids, suggested especially by the similarity of the internal and external suture-lines (compare text-fig. 88*d*, p. 257, and fig. 59*h*, p. 189), but the ribbing, for instance, in *Czekanowskites* (see fig. 90, p. 265), is different. It is probable that *Paranannites* has to be traced back to an earlier stock, and it may represent a suturally reduced, dwarf-offshoot of *Proptychitidæ*.

Paranannites aspenensis, Hyatt and Smith.

Plate XIV, figs. 6*a-c* ; text-figs. 59*a*, *h*.

1905, p. 81, pl. lxxiii, figs. 1-3 (type), figs. 4-30 ; pl. viii, figs. 1-15.

DIAGNOSIS. Subplatygyral, subpachygyral, angustumbilicate *Paranannites*. Inner whorls globose, with deep constrictions, later with numerous peripheral scales (Hyatt and Smith, pl. viii, figs. 4-6), and finally with radial folds. A deep umbilicus with high wall and distinct edge. Suture-line with broad and large external and internal saddles.

MEASUREMENTS :

Holotype (Hyatt and Smith, pl.

lxxiii, figs. 1, 2)	.	.	.	23	·47	·38	·16
C. 21869	.	.	.	26	·50	·42	·15

REMARKS. The largest example in the collection, of which the measurements are here given, has about three-quarters of a whorl of body-chamber ; it has also *Ptychites*-like folds, which are more distinct than in Hyatt and Smith's holotype and more distantly spaced, except near the end of the shell.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan. Idaho.

SPECIMENS :

C. 21869-74. Aspen Mountains, near Bear Lake, South-east Idaho, U.S.A.

Presented Dr. C. T. Trechmann, 1920 (ex

J. P. Smith Coll.).

Genus ARNAUTOCELTITES, Diener.

1916, Centralblatt, p. 101.

GENOTYPE. *Celtites arnauticus*, Arthaber, 1911, p. 267, pl. xxiv, fig. 7.

DIAGNOSIS. Micromorph, more or less globose, obliquely constricted Paranannitids with (reduced ?) ceratitic or goniatitic suture-lines.

DISTRIBUTION. Upper Eo-trias. Columbitan.

REMARKS. Diener gave no definition of this genus, nor did J. P. Smith refer to *Arnautoceltites* when creating the two genera *Juvenites* and *Thermalites* (1927, pp. 23-24), although later (1932, p. 20), unlike many continental authors, he considered Diener's genus to be properly established. Now the Albanian "*Celtites*" *arnauticus*, Arthaber, the type of the present genus, is only slightly more evolute than some of those typical "*Juvenites*" that were listed by Diener (1915a) under *Nannites* (a genus that will have to be restricted to the Upper Triassic forms of the group of *N. spurius*). These Scythian species include *N. herberti*, *N. hindostanus*, Diener, *N. medius*, v. Krafft and Diener, and *N. nov. sp. ind. (?)*, Diener, and comparable Timor forms recently described by Welter. The lateral lobe in these is entire, but, as is evidenced by what J. P. Smith figured as the adolescent stage of *Juvenites krafftii* (1927, pl. xxi, fig. 10), there may be minute toothings in this lobe ; and it is clearly impracticable to separate from the typical forms of the present genus such species as "*Paranannites*" *mediterraneus*, Arthaber, with more serrated lobes, resembling those of *Thermalites thermalium*, Smith (1927, p. 24, pl. xxi, figs. 11-20). The last is transitional to (the typically more compressed)

Paranannites, just as *J. dieneri* (Hyatt and Smith) may be considered a passage form to *Prosphingites*, a genus which has already two, serrated, lateral lobes.

Now, although these forms are probably all closely related, and although I consider the presence of slight serration in the first lateral lobe to be scarcely of sub-generic importance, I yet keep *Juvenites* distinct from the previously named *Arnautoceltites*, merely because *J. ? dieneri*, described below, with its straight constrictions and rounded umbilical border, has rather a different aspect from that of the Albanian *Arnautoceltites*. Moreover, *Juvenites* is of earlier (Owenitan) age; but its resemblance to *Anotoceras* (see p. 70) is believed to be superficial, although this somewhat homœomorphous offshoot of the Otoceratidæ has likewise been confused with *Prosphingites*.

Arnautoceltites arnauticus (Arthaber).

Plate XIII, figs. 6a-f.

1911. *Celtites arnauticus*, Arthaber, p. 267, pl. xxiv, fig. 7; Diener, 1915a, p. 73.

DIAGNOSIS. Substenogyrul to subplatygyral, subpachygyral, sublatumbilicate *Arnautoceltites*. Whorl-section depressed, with high umbilical wall, but rounded edge, and arched venter. With fine striæ of growth and oblique constrictions (5 to 11, according to age). Suture-line entire, with L deeper than E.

MEASUREMENTS :

Arthaber (holotype).	.	.	24	·35	·44	·42
C. 22862 (Pl. XIII, fig. 6b).	.	.	25	·32	·38	·38

REMARKS. In external appearance this species greatly resembles the (typically more involute) *A. mediterraneus*, which, however, has a serrated lateral lobe. Among the metatypes of these two species in the Collection there are thin and thick varieties of each, but since the suture-lines are not visible (except on grinding down the less marmorized examples), it is possible that Prof. Arthaber's own identifications are erroneous. This would confirm the view that separation of the two species into different genera, or even sub-orders, is not justifiable.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?. Albania.

SPECIMENS :

C. 22846-60, 22861-3, 22936 (?). Kčira, Albania.

Baron F. Nopcsa Coll., 1922.

Arnautoceltites mediterraneus (Arthaber).

Plate XIV, figs. 1a-c; text-figs. 59f, p. 189.

1911. *Paranannites mediterraneus*, Arthaber, p. 220, pl. xviii, fig. 8;
Diener, 1915a, p. 216.

DIAGNOSIS. Subplatygyral, pachygyral, subangustumbilicate *Arnautoceltites*. Whorl-section depressed, semilunar, with comparatively high umbilical wall and rounded, but distinct, edge. Four to seven constrictions, forming a chevron forward on periphery. Suture-line (fig. 59f) with toothed L and only two saddles.

MEASUREMENTS :

Arthaber, pl. xviii, fig. 8 . . .	16	·40	·63	·27
C. 22879 (Pl. XIV, fig. 1c). . .	18	·33	·61	·33

REMARKS. Arthaber, in 1908 (p. 274, pl. xi, fig. 7), figured a *Nannites heberti* [sic], the only example of which did not show the suture-line. In 1911, on account of the presence of five, instead of seven, constrictions, he still kept it separate from his "*Paranannites*" *mediterraneus*; but the number of varices seems too variable to be used for specific distinction. The two metatypes here figured (Pl. XIV, figs. 1a-c) show only about five constrictions. The true Himalayan *Juvenites herberti* (Diener), according to v. Krafft (1909, p. 140), has dimensions 14·43-54·29, and thus differs in its less depressed whorl-section. *Juvenites* ? *dieneri*, described below, has straighter constrictions.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ? Albania.

SPECIMENS :

C. 22879-81. Kçira, Albania.

Baron F. Nopcsa Coll., 1922.

Genus **JUVENITES**, J. P. Smith.

1927, p. 23 (= "*Thermalites*", J. P. Smith, 1927, p. 24).

GENOTYPE. *Juvenites krafftii*, J. P. Smith, 1927, p. 23, pl. xxi, figs. 1-3 (4-10).

DIAGNOSIS. More-or-less involute, micromorph, often constricted Paranannitids, with suture-lines entire or feebly ceratitic.

DISTRIBUTION. Upper Eo-trias. Owenitan.

REMARKS. As mentioned above under *Arnautoceltites*, the present genus is taken to include also "*Thermalites*" *thermarum*, J. P. Smith (1927, p. 24, pl. xxi, figs. 11-14, 15-20); but the same author's "*Prenkites*" *depressus*, Smith (1932, p. 110, pl. xxxi, figs. 16-18), is more doubtful. This generic attribution, as well as J. P. Smith's statement that "*Thermalites*" was probably identical with *Isculitoides originis* (Arthaber), cannot be accepted.

Juvenites (?) dieneri (Hyatt and Smith).

Fig. 59*d*, p. 189.

1905. *Nannites dieneri*, Hyatt and Smith, p. 79, pl. vii, figs. 10-13 (5-9, 14-25); Diener, 1915*a*, p. 207.

DIAGNOSIS. Subplatygyral to platygyral, perpachygyral, subangustumbilicate *Juvenites*?. With fine radial striation on test; cast smooth, with generally faintly marked constrictions, which are more numerous and with intervening folds on the outer whorl. Suture-line goniatitic, with deep external lobe and large external saddle.

MEASUREMENTS :

Holotype (fig.)	.	.	19	.	·47	.	·66	.	·19
Hyatt and Smith (p. 80)			13·5	.	·52	.	·67	.	·20

REMARKS. This species was united by Arthaber (1908, p. 274) with Diener's *Nannites herberti*, whilst v. Krafft (in v. Krafft and Diener, 1909, p. 142) considered it nearly allied to *N. hindostanus*, Diener. The perfect rounding of the umbilical edge, however, the peculiar straightness of the constrictions and the slight differences in suture-line seem to me sufficiently important for specific separation; and it has already been mentioned that the present species may even be considered to be transitional to *Prosphingites*, with similar constrictions and whorl-shape.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan (= Meekoceratan). California; Idaho.

SPECIMENS :

C. 21875-7. Near Hot Springs, South-east Idaho, U.S.A.

Presented Dr. C. T. Trechmann (ex

J. Perrin Smith Coll.).

Genus **PROSPHINGITES**, Mojsisovics.

1886, p. 64.

GENOTYPE. *P. czezanowskii*, Mojsisovics, 1886, p. 64, pl. xv, figs. 10-12.

DIAGNOSIS. Smooth Paranannitidæ with globose inner, and sometimes almost keeled, galeate or compressed outer whorls. Suture-line ceratitic, with one lateral lobe, two auxiliaries outside and two more inside the umbilical suture. Internal lobe and saddles long and narrow.

DISTRIBUTION. Upper Eo-trias, Owenitan ? to Prohungaritan. California; Siberia; Spitsbergen; Albania.

REMARKS. This genus may first appear in the *Mækoceras* Beds of California with a form (" *P.*" *austini*, Hyatt and Smith) that seems to differ from the associated *Juvenites* and *Paranannites* chiefly in its more advanced suture-line. The genotype, however, is rather distinct and foreshadows certain later forms, notably *Sphingites*; but this resemblance is probably merely a case of homœomorphy.

Diener (in v. Krafft and Diener, 1909, p. 160) even thought that *Anotoceras nala* and *A. kama* (Diener), with sharp umbilical rims, were closer to the type of *Prosphingites* than Hyatt and Smith's "*P.*" *austini*, which had constrictions and no contracted body-chamber, and might therefore be more correctly grouped with *Popanoceras*. It is here held, however, that the resemblance between *Anotoceras* and *Prosphingites* is superficial (see *supra*, p. 70); the presence of constrictions in the Californian species, as in the more typical Spitsbergen form here figured, only indicates their close affinity with the Paranannitidæ.

Prosphingites spathi, Frebold.

Plate XIII, figs. 1a-e, 2.

1921. *Prosphingites* ? sp. nov., Spath, pp. 298, 301.

1930. *Prosphingites spathi*, Frebold, p. 20, pl. iv, figs. 3, 3a (2).

DIAGNOSIS. *Prosphingites* with subplatygyral, pachygyral, subangustumbilicate to sublatumbilicate coiling. Whorl-section very depressed on inner, more rounded on outer, whorls; venter arched; umbilical edge first rounded, later angular, with wall becoming less high, but more vertical, or even overhanging. Surface smooth or with faint striæ and ridges, also with

constrictions, which occasionally cause bulges on the ventral area. Suture-line (Pl. XIII, fig. 1e) with large external saddle and two ceratitic lateral lobes.

MEASUREMENTS :

Frebold, p. 21	27	·41	·60	·30
Pl. XIII, figs. 1a, b	26	·40	·56	·30
Pl. XIII, fig. 1c	26	·35	·56	·35
Evolute var. (Pl. XIII, fig. 1d)	24	·35	·54	·42
Pl. XIII, fig. 2	32	·40 ?	·60	·30 ?

REMARKS. When first recording the present species, I stated that the sixty-six examples included several new forms, but that they all agreed in suture-lines. It is now held that they all belong to one variable species, which is obviously the same as that described by Frebold ; and there are many transitions between the smooth examples and those in which radial folds and the "pseudo-constrictions" are pronounced ; between the involute and evolute varieties ; and between the compressed and inflated types. The external resemblance to *Juvenites herberti* and *J. hindostanus* (Diener), to which I referred, is considerable ; but apart from the differences in the suture-lines, the former is distinguished by its oblique constrictions and rounded umbilical wall ; the latter by its compressed whorl-section and absence of a high umbilical rim. The doubtful *Prospiringites austeni*, Hyatt and Smith (1905, p. 72, pl. vii, figs. 1-4), has a smaller and shallower umbilicus, but the inner whorls of *P. czekanowskii*, the genotype, are closely similar. The body-chambers of the species here described, however, show only slight contraction, and the ventral area remains broad and becomes comparatively coarsely folded.

The example previously recorded as being attached to a typical *Arctoceras* may well belong to another form rather than the present species, but it is too small and poorly preserved to be definitely identified.

HORIZON AND LOCALITIES. Upper Eo-trias. Spitsbergen.

SPECIMENS :

C. 27086-128, 30510-11. Sassen Bay.

J. W. Gregory Coll., 1896.

C. 27130-49. Lowest line (of nodules ?), 450 ft. above camp,
Mt. Marmier, Sassendal. *Same Coll.*

? C. 27129. (In block with *Arctoceras*), Trident, Sassendal.

E. J. Garwood Coll., 1896.

Genus **ISCULITOIDES**, Spath.

1930, p. 85 (= *Isculites*, Arthaber, 1911, p. 258, *non* Mojsisovics, 1893; *non* " *Thermalites* ", Smith, 1927, p. 24).

GENOTYPE. *Isculites originis*, Arthaber, 1911, p. 259, pl. xxiii, figs. 1a-c (2-10).

DIAGNOSIS. More-or-less involute, subglobose and smooth Parannanitidæ with contracting body-chamber, and having a mouth-border with projected ventral lappet. Suture-line simple, with only two ceratitic lobes.

DISTRIBUTION. Upper Eo-trias, Columbitan ?. Albania.

REMARKS. The Carnian genus *Isculites* (genotype: *I. decrescens*, Hauer) was correctly placed by Mojsisovics near *Anatomites*, and in the Haloritidæ. The Anisian forms referred to the genus *Isculites*, like *I. hauerinus* (Stoliczka) and *I. middlemissi*, Diener, on account of the more numerous elements of their suture-lines and their larger size, are closer to *Smithoceras*, which was included by Diener in Haloritidæ rather than Arces-tidæ. There is as little resemblance of this Anisian group, correctly separated as *Spitisculites* by Diener (1916, p. 101), to the Neotriassic true *Isculites* as to the early forms here renamed *Isculitoides*; and the differences in suture-line are far more important than is the accidental resemblance in the contraction of the body-chamber—a feature which may occur in any stock. The Eo-triassic forms seem to attach themselves much more naturally to *Prosphingites* and other Parannanitids, as was recognized by Prof. J. Perrin Smith (1927, p. 24), who, however, included the Albanian forms in the group here united in *Juvenites* (+ " *Thermalites* "). If these are considered to be the ancestors of Arcestids and Ptychitids as well as of other families, the occurrence of homœomorphs of *Isculitoides* in the later stocks would be easily explained.

It seems probable that Arthaber's Lower Triassic " *Styrites* " (*non* Mojsisovics), compared with a Himalayan form of much later date, represents merely a specialized offshoot of the present stock. It is, however, known in only two specimens, one of which is lost, but its goniatitic suture-line (see fig. 59e, p. 189), combined with the sharpened periphery, might well justify its generic separation, since the resemblance to the Neo-triassic *Styrites* (family Tropitidæ) is obviously superficial.

? Genus **PARAGOCERAS**, Arthaber.

1911, p. 265.

GENOTYPE. *P. dukagini*, Arthaber, 1911, p. 265, pl. xxiv, fig. 6.

DIAGNOSIS. Smooth, inflated Paranannitidæ, with globose inner, and more evolute, uncoiling, outer whorls. With rounded umbilical slope and broadly arched venter. About six strongly prorsiradiate constrictions in adult. Suture-line with very wide, ceratitic L and only one lateral saddle.

DISTRIBUTION. Upper Eo-trias, Columbitan ?. Albania.

REMARKS. This genus is probably only a dwarf development of *Isculitoides*, but is known in only a single, poorly preserved



FIG. 60.—*Paragoceras dukagini*, Arthaber. Side and peripheral views and suture-line (enlarged $\times 5$) of holotype. Lower Trias. Albania. (After Arthaber, 1911, pl. xxiv, figs. 6a-c.)

example. There is general resemblance in whorl-shape to *Arnaudoceltites*, e. g. *A. mediterraneus* (Arthaber). If the details of the suture-line of *Paragoceras* as drawn by Arthaber (see fig. 60c) prove correct, the generic independence of *Paragoceras* would be justified; but to those who have experienced the difficulty of preparing the suture-lines of the badly preserved Albanian material, the unusual appearance of the external lobe may require confirmation.

Subfamily COLUMBITINÆ, nov.

DIAGNOSIS. Discoidal or globose developments of a primitive Meekoceratid stock with (cœnogenetic) early coronate stage, or corresponding (spiral) umbilical ridge. Venters arched to

keeled. Suture-line typically with only one differentiating lateral lobe.

REMARKS. The genus *Columbites*, Hyatt and Smith, was first referred to the Sibiritidæ—indeed, immature examples show great resemblance to the young of such forms as the *Anasibirites* from Timor, figured by Welter. There is equal similarity, however, to other immature coronate forms before the characteristic ornamentation and whorl-shape appear. In *Sub-*

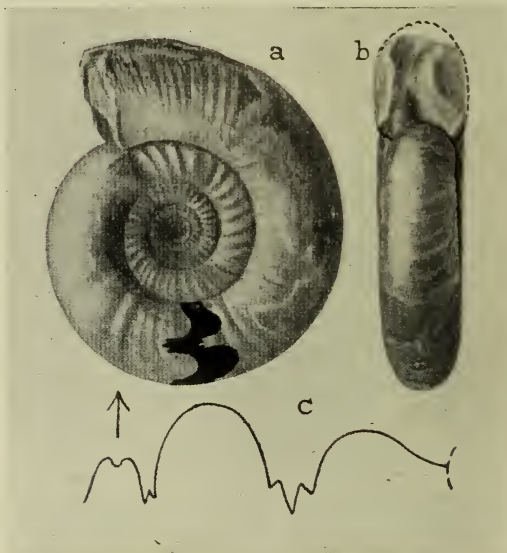


FIG. 61.—*Columbites parisianus*, Hyatt and Smith. Side- and peripheral views and suture-line (enlarged $\times 3$) of holotype. (After Hyatt and Smith, 1905, pl. i, figs. 9–11.)

columbites, Spath (p. 202), created for the Albanian "*Columbites*", the resemblance to the more primitive Xenoceltitids is considerably less, and a keel as well as reticulation of the striate ornamentation are becoming conspicuous. *Protropites*, *Prenkites* and *Arianites* are more-or-less extreme offshoots in different directions of the same stock, simulating Paranannitids. *Epiceltites*, provisionally included here, seems to be an exceptionally discoidal development.

The large external saddle and single lateral lobe may be considered to be characteristic of Columbitinæ, but the genus

Paragoceras, and even *Isculitoides*, are transitional in this respect between the present sub-family and the Paranannitinae.

Genus **COLUMBITES**, Hyatt and Smith.

1905, p. 50 ; Diener, 1915a, p. 112.

GENOTYPE. *Columbites parisianus*, Hyatt and Smith, 1905, p. 51, pl. i, figs. 9-11.

DIAGNOSIS. Evolute, feebly ornamented Columbbitidæ, with arched venter, tending to become acute, and with coronate inner whorls. Suture-line with only one trifold lateral lobe and two broad saddles.

DISTRIBUTION. Upper Eo-trias, Columbbitan. Idaho.

REMARKS. Hyatt and Smith, in 1905, stated that *Columbites* was represented in Idaho by *C. parisianus*, the genotype, and four undescribed species. In 1914 Smith described the additional *C. spencei* (p. 36, pl. lxx, figs. 1-16, pl. lxxi, figs. 1-16), which does not differ from *C. parisianus* in any important feature, and is merely slightly more inflated and ornamented. The two Anisian species referred by Smith to *Columbites* are discussed below under *Tropigastrites*.

Columbites parisianus, Hyatt and Smith.

Plate XIII, fig. 3, text-fig. 61, p. 200.

1905, p. 51, pl. i, figs. 9-11 (holotype), figs. 12-14.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Columbites*. Striate, with strong peripheral projection, *i. e.* with sinus projecting forwards in adult; costate and tuberculate at earlier stages. Innermost whorls coronate and constricted. For suture-line see generic diagnosis and fig. 61c, p. 200.

MEASUREMENTS :

Holotype (Hyatt and Smith, pl. i,							
figs. 9-10)	.	.	.	.	47	·30	·26? 47
C. 21867	.	.	.	.	57	·30	·26 47

REMARKS. The completely septate example figured in Pl. XIII, fig. 3, shows the tuberculate inner whorls and traces of nodes still persisting on the costæ of its outer volution. Two of the specimens in the Collection are transitional to *C. spencei*, Smith, already referred to, with more robust whorl-shape and ornamentation.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbbitan. Idaho.

SPECIMENS :

C. 21867-8, 29100-1. Paris Canyon, one mile west of Paris, South-west Idaho, U.S.A. (ex *J. P. Smith Coll.*).

Presented Dr. C. T. Trechmann, 1920.



FIG. 62.—*Subcolumbites* and *Prenkites*. *a, b*, *Subcolumbites mirdi-tensis* (Arthaber), var. Side- and peripheral views. Lower Trias. Albania. *c*, *S. europæus* (Arthaber). Suture-line. Same locality. *d, e*, *Prenkites timorensis*, Spath. Side and peripheral views of holotype, from the Lower Trias, Nifoekoko, Timor (= *Columbites* nov. sp. ind. in Welter). *f, g, h*, *Prenkites malsorensis*, Arthaber. Outline peripheral view and suture-lines of two examples (enlarged $\times 2$ and $\times 6$, respectively). Lower Trias. Albania. (After Arthaber, 1911, pl. xxiv, figs. 4*a, b*, pl. xxiii, fig. 15*c*; Welter, 1922, pl. clxviii, figs. 12, 13; and Arthaber, 1911, pl. xxii, figs. 17*b, c*, 18.)

Genus SUBCOLUMBITES, Spath.

1930, pp. 77, 90.

GENOTYPE. *Columbites perrini-smithi*, Arthaber, 1908, p. 277, pl. xii, figs. 1*a-c*.

DIAGNOSIS. Like *Columbites*, but with the tendency to carination more pronounced, reticulate ornamentation, and early tuberculate stage absent or inconspicuous.

DISTRIBUTION. Upper Eo-trias, Columbitan ?. Albania; Timor ?.

REMARKS. Hyatt and Smith considered *Columbites* to connect the Carboniferous and Permian "*Gastrioceras*" with the Upper Triassic *Tropites*. Arthaber considered that his Albanian forms (now *Subcolumbites*) confirmed the derivation from the older group, but thought he had found the ancestor of *Tropites* in his new genus *Protropites*. Since the Columbbitids are all closely related, this substitution of *Protropites* for *Columbites* or *Subcolumbites* makes little difference; but there can be no doubt that the resemblance to the early *Gastrioceras* as well as to the late *Tropites* is merely a case of homœomorphy. The cœnogenetic appearance of a coronate post-embryonic stage or the formation of a keel on the outer whorls has occurred too often in entirely unrelated stocks to be of any phylogenetic significance. The similarity of certain *Sybillites* and *Tropites* to forms of Columbbitidæ is not even so striking as that of, say, "*Margarites*" (Mojsisovics, 1889, p. 278, *non* Gray, 'Ann. and Mag. Nat. Hist.', vol. xx, 1847, p. 271, no. 86) to such unrelated later stocks as certain Arietids, Sonninids, etc.

The four species of *Subcolumbites* recorded below are very closely allied, and connected by many transitions; a number of the less well preserved examples cannot therefore be definitely identified.

Subcolumbites perrini-smithi (Arthaber).

Plate XII, figs. 5a, b.

1908, p. 277, pl. xii, fig. 1; 1911, p. 262, pl. xxiii, figs. 19, 20.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Subcolumbites*. Whorl-section elliptical, with subcarinate venter and rounded, slightly overhanging, umbilical border. Conspicuous prorsiradiate lineation, crossed by fine strigation. Suture-line as in *S. europæus* (fig. 62c, p. 202).

MEASUREMENTS :

Arthaber, 1911, p. 262, No. I	.	38	·40	·32	·42
" " " " II	.	54	·31	·26	·44

REMARKS. The dimensions given by Arthaber for the first example (quoted above) include a whorl-height of 40 per cent., which is apparently an error. Judging by the figure of the holotype (1908), the two later (1911) illustrations, and a number of examples in the Collection (determined by Prof. Arthaber himself), the whorls are even narrower at smaller diameters than in the adult. In the typical specimen here figured (Pl. XII,

figs. 5*a*, *b*), the whorl-height amounts to 30% of the diameter (at 40 mm.). A number of the specimens listed below are transitions to the more robust species next described, and especially to what Prof. Arthaber labelled the "plicated variety" of *C. europæus*. One pathological example has a spiral depression on one side.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?
Albania.

SPECIMENS :

C. 911-15, 22916-23, 22924-6. Kçira, Albania.

Baron F. Nopcsa Coll., 1922.

Subcolumbites europæus (Arthaber).

Plate XII, figs. 6*a*, *b* ; text-fig. 62*c*, p. 202.

1908, p. 278, pl. xii, fig. 2 (holotype) ; 1911, p. 261, pl. xxiii, figs. 13-18.

DIAGNOSIS. Like *S. perrini-smithi*, but with more depressed whorls and broader, less distinctly carinate, periphery. (Suture-line see fig. 62*c*, p. 202.)

MEASUREMENTS :

Arthaber, 1911, p. 261, No. 3	.	39	·36	·38	·38
„	„	4	·55	·33	·38
					·42

REMARKS. The two small examples here figured show the delicate ornamentation and absence of the coarsely tuberculate early stage of the typical *Columbites*. At that stage the whorl-thickness is considerably greater than the height, and these proportions remain fairly constant in the adult *Subcolumbites europæus*, whilst *S. perrini-smithi*, and less so *S. dusmani*, show flattening of the outer whorls. *S. mirditensis* is more depressed, and has a prominent and sharp umbilical rim, like *Arianites*.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?
Albania.

SPECIMENS : C. 22890-900, 22901-10. Kçira, Albania.

Baron F. Nopcsa Coll.

Subcolumbites dusmani (Arthaber).

1911, p. 263, pl. xxiv, figs. 1*a*-*d*.

DIAGNOSIS. Like *S. europæus*, but the whorls have flattened sides and the striæ are less projected. Less flattened and

carinate than *S. perrini-smithi*. With high umbilical wall with distinct edge.

MEASUREMENTS :

Arthaber, pl. xxiv, figs. 1a, b .	38	·34	·37	·40
C. 22927	47	·34	·36	·40

REMARKS. This species is scarcely more than a variety of *S. europæus*, and some of the examples in the Collection, identified by Prof. Arthaber, probably must be referred to that species. Others are transitional to *S. mirditensis*, with very depressed whorls.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?. Albania.

SPECIMENS :

C. 22927-35. Kçira, Albania (metatypes).

Baron F. Nopcsa Coll., 1922.

Subcolumbites mirditensis (Arthaber).

1911, p. 263, pl. xxiv, figs. 2 (typus), 3, 4 (*Columbites mirditensis*).

DIAGNOSIS. Like *S. europæus*, but more depressed and with prominent, sharp, umbilical edge.

MEASUREMENTS :

Arthaber, p. 264, No. 3 .	37	·32	·51	·41
„ „ „ 4 .	48	·40	·54	·46

REMARKS. This species is connected with *S. europæus* by transitional forms, of which Arthaber's pl. xxiv, fig. 4, is one. The Collection includes several examples of this "variety", distinguished from the typical specimens by decrease in whorl-thickness and rounding of the umbilical edge. The large example figured by Arthaber (pl. xxiv, figs. 3a, b = No. 4 of above measurements) has a prominent keel, like *S. perrini-smithi*, but its whorls are far more depressed.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?. Albania.

SPECIMENS :

C. 22883-6, 22887-9. Kçira, Albania.

Baron F. Nopcsa Coll., 1922.

Genus **PROTROPITES**, Arthaber.

1911, p. 255, Diener, 1915a, p. 235.

GENOTYPE. *P. hilmi*, Arthaber, 1911, p. 256, pl. xxii, figs. 15a, b (9-14, 16).

DIAGNOSIS. More-or-less involute and inflated Columbitidæ with cadicone inner, and carinate outer, whorls. Prorsiradiate striation, as in *Subcolumbites*. Suture-line subceratitic, with wide lateral lobe (Pl. XIII, fig. 4c).

DISTRIBUTION. Upper Eo-trias, Columbitan ?. Albania.

REMARKS. The traces of lineation marked on the prominent umbilical edge of the *Gastrioceras*-like inner whorls show the affinity of *Protropites* with *Subcolumbites*, on the one hand, and with *Prenkites* on the other. *Protropites* is believed to be merely an extreme development of *Subcolumbites mirditensis*, described above, with corresponding modification of the suture-line.

Protropites hilmi, Arthaber.

Plate XIII, figs. 4a-c.

1911, p. 256, pl. xxii, figs. 15a, b (lectotype) ; figs. 9-14, 16.

DIAGNOSIS. Subplatygyral, pachygyral to subleptogyral; subangustumbilicate to sublatumbilicate *Protropites*. Cadicone, smooth, inner whorls; excentrumbilicate, compressed outer whorl, with prominent hollow keel. Strongly projected striation, continuous across carina. Suture-line with high external, and small lateral, saddle.

MEASUREMENTS :

Arthaber, 1911, p. 256, No. 1	.	16	·38	·50	·31
„ „ „ 5	.	32	·38	·31	·38

REMARKS. Arthaber pointed out that the barrel-shaped inner whorls persist to different diameters in different individuals, and he recognized varieties with comparatively inflated, and with more flattened, outer whorls. The example here figured (Pl. XIII, fig. 4a) is comparable to Arthaber's fig. 12a, b (pl. xxii), referred to the " flatter " variety ; the sectional outline (fig. 4b), taken from Arthaber's pl. xxii, fig. 14b, belongs to the " inflated " variety.

The cadicone inner whorls may be mistaken for those of *Prenkites*, described below, but these, when well enough preserved, show a different suture-line. *Subcolumbites*, like *S. mirditensis* with keeled outer whorls (see Arthaber, 1911, pl. xxiv, fig. 3), lack the very depressed barrel-shaped inner whorls.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?. Albania.

SPECIMENS :

C. 22838-45. Kçira, Albania. Baron F. Nopcsa Coll., 1922.

Genus **PRENKITES**, Arthaber.

1911, p. 257 ; Diener, 1915a, p. 226.

GENOTYPE. *P. malsorensis*, Arthaber, 1911, p. 258, pl. xxii, figs. 17a-c (lectotype), 18, 19a, b.

DIAGNOSIS. Excentrumbilicate, cadicone Columbitedæ, with indications of umbilical tubercles on inner whorls, and constricted body-chambers and aperture. Suture-line ceratitic, with deep external, and two lateral, lobes.

DISTRIBUTION. Upper Eo-trias, Columbitan ?. Albania ; Timor.

REMARKS. The two forms from Timor figured by Welter (1922, pl. clxviii, figs. 12, 13 and 18-20) are important for tracing the affinity of *Prenkites*. The first species, here refigured (fig. 62d, e), which has already been given a name (*Prenkites timorensis*, Spath), is not a *Columbites*, as described by Welter ; whilst the second form, referred by the same author to *Prenkites*, is much closer to *Columbites* in whorl-shape, and to *Subcolumbites* in suture-line. The very characteristic change in the originally cadicone whorl-shape of *P. timorensis*, indicated by the loosening of the outer whorl, certainly shows that it is not a *Columbites* (or *Subcolumbites*) ; but the possibility of the two genera being thus differently interpreted shows that they must be closely allied. In *P. malsorensis*, the genotype, the ribbing of the outer whorl is not very pronounced, but is strongly drawn forwards on the periphery, where also indistinct strigation may be observed, as in *Subcolumbites*.

The resemblance to *Tropites* in the change of whorl-shape of the adult was considered significant by Arthaber, who also pointed out that the suture-line of young *Tropites* agreed almost exactly with that of fully grown *Prenkites* ; but similar resemblance might be discovered in many other unrelated stocks, just as the young of any cadicone ammonite are bound to resemble *Gastrioceras*. The Liassic Arietid offshoot *Pseudotropites*, Waehner, is still more like the true Carnian *Tropites* ; and yet we know that it must have been derived through *Paracaloceras* and *Psiloceras* from the Phylloceratid root-stock, which differs so greatly in its morphology from that of *Tropites*.

Prenkites malsorensis, Arthaber.Plate XII, figs. 7*a-c*; text-figs. 111*f-h*.

1911, p. 258, pl. xxii, figs. 17-19.

DIAGNOSIS. First subplatygyral, later substenogyral, pachygyral, subangustumbilicate to latumbilicate *Prenkites*, with uncoiling body-chamber, with a constricted aperture parallel to peripherally projected striæ of growth. Whorl-section (fig. 62*f*, p. 202) like the early, uncarinate part of *Protropites*. Suture-line (figs. 62*g, h*) with wider external lobe than in *Subcolumbites*.

MEASUREMENTS :

Arthaber, p. 258 (Typus)	.	26	.	·35	.	·54	.	·58
„ „ (var.)	.	26	.	·35	.	·54	.	·50

REMARKS. Arthaber distinguished a "variety" with smaller umbilicus (see measurements, above) and more ellipsoidal whorl-shape, but among the twenty-six metatypes in the Collection (five of which were labelled by Prof. Arthaber as the "variety"), there is such variability that the recognition of definite "varieties" seems useless. Some, however, in their more rounded umbilical edges, carrying subcolumbitid, comma-shaped ribs, are transitional to *Protropites*, which differs mainly in the comparatively unimportant feature of a (transitory) keel.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?
Albania.

SPECIMENS :

C. 22726-51. Kçira, Albania. *Baron F. Nopcsa Coll.*, 1922.

Prenkites timorensis, Spath.Fig. 62*d, e*, p. 202.

Columbites nov. sp. ind. Welter, 1922, p. 150, pl. clxviii, figs. 12, 13.
Spath, 1930, p. 77.

DIAGNOSIS. *Prenkites* resembling *P. malsorensis*, but the constrictions of the inner whorls become associated with ribs, and form on the body-chamber a *Palæophyllites*-like costation, with siphonal chevrons so pronounced as to form a median crest. Suture-line with two saddles, more rounded than in *P. malsorensis* (fig. 62*h*, p. 202).

MEASUREMENTS :

Welter, pl. clxviii, figs. 12, 13	.	30·5	·38	·52	·39
C. 33714	.	32	·38	·53	·38

REMARKS. The cadicone inner whorls of this species and the contracted body-chamber agree with the typical *Prenkites*,

but its ornamentation is that of *Subcolumbites* of the type of *S. mirditensis* (Arthaber), leading to the keel of *Protropites*. The suture-line, unknown to Welter, is visible in the specimen from Timor in the Collection, and shows a shallower and much wider lateral lobe than the same author's "*Prenekites*" *sundaicus*, already referred to.¹ It agrees more with the suture-line of Arthaber's *P. malsorensis*, but the saddles are still shorter; the ventral lobe, unfortunately, cannot be exposed. The test of the globose inner whorls is beautifully preserved and has distinct strigation, in addition to the constrictions with



FIG. 63.—*Arianites musacchi*, Arthaber. Side- and peripheral views and suture-line (enlarged $\times 2$) of holotype from the Lower Trias. Albania. (After Arthaber, 1911, pl. xxiv, figs. 5a-c.)

the pronounced chevron of Arthaber's "*Celtites*" *arnauticus* (1911, pl. xxiv, fig. 7).

HORIZON AND LOCALITIES. Upper Eo-trias (*Palæophyllites* Bed, Prohunganitan). Timor.

SPECIMENS :

C. 33714. Nifoekoko.

M. E. Walsh Coll., 1930.

Genus **ARIANITES**, Arthaber.

1911, p. 264; Diener, 1915a, p. 53.

GENOTYPE. *A. musacchi*, Arthaber, 1911, p. 264, pl. xxiv, figs. 5a-c.

DIAGNOSIS. Columbbitidæ derived from *Subcolumbites*, with pronounced umbilical rim and a simple suture-line, which has a deep external lobe and a bifid lateral lobe.

¹ A compressed individual of this species has now been found in the M. E. Walsh Coll. (No. C. 37186).

DISTRIBUTION. Upper Eo-trias, Columbitan ?. Albania.

REMARKS. Arthaber considered this genus to be a relic of some palæozoic stock, but it was based on a single, poorly preserved example and occurred with a wealth of Columbites. If Arthaber's drawing is reliable, *Arianites* is only a Columbites with extreme sutural development; and the discovery of further examples will undoubtedly prove it to be connected with *Subcolumbites* by transitions.

INCERTÆ SEDIS.

? Genus **EPICELITITES**, Arthaber.

1911, p. 267; Diener, 1915a, p. 131.

GENOTYPE. *E. gentii*, Arthaber, 1911, p. 268, pl. xxiv, fig. 8.

DIAGNOSIS. ? Columbites having evolute, compressed shells, with fine lineation and periodic flares or constrictions. Suture-line with single, ceratitic, lateral lobe.

DISTRIBUTION. Upper Eo-trias, Columbitan ?. Albania.

REMARKS. Arthaber united *Epicelites* with his "*Celites*" *arnauticus* (here described as *Arnautocelites*, see p. 192) in the family Celitidae; but the resemblance of the outer whorls in the two stocks, striking enough on comparison (see *e.g.*, figs. 5 and 6 of Pl. XIII), is probably purely accidental. The inner whorls of *Arnautocelites* are depressed; in *Epicelites* they are compressed, and there is a resemblance in coiling to *Hemilecanites*, and even *Eophyllites*. The suture-line of *Epicelites* is against association with the last, but resembles that of *Subcolumbites europæus*, as does the ornamentation and serrated ventral area, for example, in the specimens figured by Arthaber in pl. xxiii, figs. 17a-c. Similar ornamentation is found again in certain Xenocelites, but the close resemblance in suture-line to *Subcolumbites* makes it advisable to refer *Epicelites* provisionally to Columbites. The tendency in this family is generally to involute and globose, and not to discoidal, evolute forms; but it has already been mentioned that they probably have a common origin with Xenocelites.

Epicelites gentii, Arthaber.

Plate XIII, figs. 5a-d.

1911, p. 268, pl. xxiv, figs. 8a-d.

DIAGNOSIS. Subplatygyral, subleptogyral, sublatumbilicate *Epicelites*. Whorl-section elliptical, with periphery tending to

become crenulate in the median line owing to strongly projected ornamentation. Suture-line, see fig. 64*d*.

MEASUREMENTS :

Arthaber, pl. xxiv, fig. 8	.	36	.	·36	.	·25	.	·40
C. 22872	.	.	.	27	.	·35	.	·22 ?
								·39

REMARKS. The peculiar close constrictions of the body-chamber are well seen in the fragment figured in Pl. XIII, fig. 5*b* (natural size) and 5*d* (enlarged $\times 2$); the usual monophyllitoid ornamentation of the early septate whorls is seen in fig. 5*a*. In *Arnautoceltites arnauticus* (Arthaber) with somewhat similar



FIG. 64.—*Epiceltites gentii*, Arthaber. Side- and peripheral views, with part of ventral area enlarged ($\times 2$) and suture-line ($\times 2$) of holotype. Lower Trias. Albania. (After Arthaber, 1911, pl. xxiv, figs. 8*a-d*.)

but more oblique constrictions on the body-chamber (see Pl. XIII, fig. 6*a*), the periphery is broadly arched, not crenulate.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?. Albania.

SPECIMENS :

C. 22867–74. Kčira.

Baron F. Nopcsa Coll., 1922.

g. Family USSURIDÆ, Spath.

1930, p. 40.

DIAGNOSIS. Involute, smooth, discoidal ammonites, with arched to sub-acute venters and flat whorl-sides. Suture-line ammonitic, highly frilled; with monophyllitic external saddle

(*Ussuria*), adventitious saddle (*Metussuria*), or minutely subdivided external saddle (*Parussuria*).

REMARKS. Hyatt (1900, p. 566) created a family Ussuritidæ to include the genus *Ussuria*, also *Ussurites*, which was based on *Monophyllites sichoticus*, Diener. The separation of the latter from *Monophyllites*, relegated by Hyatt to a different family (Megaphyllitidæ), cannot be admitted; and in the 1913 edition of Zittel's Textbook, Prof. J. P. Smith (p. 637) not only omitted *Ussurites* altogether, but included *Ussuria* with the Permian family Thalassoceratidæ, as he still did in 1932 (p. 90). The writer (1914, p. 357) previously accepted the sequence from *Dimorphoceras*, through *Thalassoceras*, to *Ussuria* as a true lineage, but this view is not now tenable, nor is Prof. Arthaber's reference of *Ussuria* to Carnitidæ, as Prof. Diener (1915*b*, p. 29) has already stated. In its normal growth from young to adult a form with the suture-line of *Ussuria* is bound to pass through stages that show some resemblance to less specialized types of earlier periods. Like the Proptychitids (and *Procarnites*), the present family represents a group of specialized offshoots of the common Eo-triassic "Meekoceratid" root-stock, *i. e.* the Gyronitids. It is important to note that such a typical Flemingitid as *F. pulcher*, Welter (1922, p. 114, pl. clxiii, figs. 1, 2), has a wide external lobe, with prominent median saddle, and a monophyllic external saddle, although its first lateral lobe and saddle are different from those found in Ussurids. Monophyllitids similarly have an independent origin in some Gyronitid (Flemingitid ?) stock parallel with Gymnitidæ, and cannot be descended from the highly specialized *Ussuria*.

Genus **USSURIA**, Diener.

1895*c*, p. 270; 1895*a*, p. 25; Diener, 1915*a*, p. 310; 1915*b*, p. 28.

GENOTYPE. *Ussuria schamaræ*, Diener, 1895*a*, p. 26, pl. iii, figs. 4*a-c* (*fide* Diener, 1915*a*, p. 310).

DIAGNOSIS. Ussuritidæ having a submonophyllic suture-line, with two lateral saddles notched only on inner side.

DISTRIBUTION. Lower (?) Eo-trias. Siberia.

REMARKS. Diener considered it inadmissible to separate generically from *Ussuria* the forms with adventitious saddles; but it is necessary to go even farther and to exclude "*Ussuria*" *compressa*, Hyatt and Smith, which differs in suture-line as well as in whorl-shape and *Sturia*-like strigation, and which may

well belong to a different horizon. Diener's *Ussuria iwanowi* (1895a, p. 27, pl. iii, fig. 5), and the new Timor species recorded by Welter (1922, p. 100, pl. iii, fig. 10) as *Ussuria* nov. spec. ind. ex aff. *iwanowi*, are transitional from the true, restricted, *Ussuria* to *Parussuria*, but still retain monophyllic saddles. Hyatt and Smith (1905, p. 88) selected *U. iwanowi* instead of *U. schamaræ* as genotype. Diener's view, however, is here adopted, since, on the one hand, he cites Hyatt and Smith, and

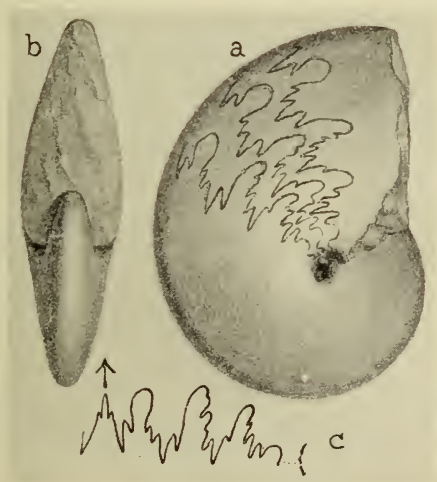


FIG. 65.—*Ussuria schamaræ*, Diener. Eo-trias. Ussuri, Siberia.
(After Diener, 1895a, pl. iii, figs. 4a-c.)

on the other, in his Introduction, makes it clear that he has not flouted the laws of priority, so that his listing of "*Ussuria*, nov. gen. *schamaræ* nov. sp." (1895c, p. 270) must have seemed to him definite and binding.

Genus **PARUSSURIA**, nov.

GENOTYPE. *Ussuria compressa*, Hyatt and Smith, 1905, p. 89, pl. iii, figs. 6-11 (*Sturia compressa*, J. P. Smith, 1932, p. 93, pl. iii, figs. 6-11).

DIAGNOSIS. Ussuridæ having a suture-line with all the saddles deeply divided (fig. 66c, d).

DISTRIBUTION. Upper Eo-trias. California.

REMARKS. The whorl-shape is more oxynote and more lenticular than in *Ussuria* and *Metussuria*, and the spiral striation of the present genus has not been observed in the other Ussurids. The suture-line is much more complex and ammonitic than that of *Ussuria* and has no adventitious lobe as in *Metussuria*.

There is no genetic connection between *Sturia*, Mojsisovics, and any of the Ussurids, in spite of the "not inconsiderable analogies" noticed by Mojsisovics (1902, p. 306).

Genus **METUSSURIA**, nov.

GENOTYPE. *Ussuria waageni*, Hyatt and Smith, 1905, p. 90, pl. lxxv, figs. 3-5 (lectotype), figs. 1, 2; pl. lxxvi, figs. 1-12; pl. lxxvii, figs. 1-2; pl. lxxxv, figs. 1-8.

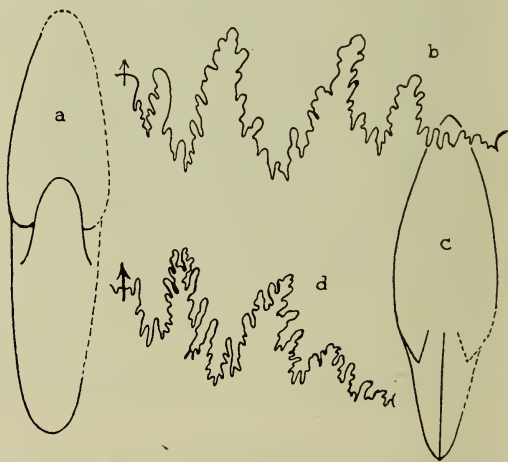


FIG. 66.—a, b, *Metussuria waageni* (Hyatt and Smith). Upper Eo-trias, Owenitan. California. (After Hyatt and Smith, 1905, pl. lxxv, figs. 4 [adapted] and 2, reduced to $\frac{2}{3}$ linear.) c, d, *Parussuria compressa* (Hyatt and Smith, 1905, pl. iii, figs. 7 [adapted] and 9, reduced to $\frac{2}{3}$ linear). Upper Eo-trias, Owenitan. Idaho, U.S.A.

DIAGNOSIS. Ussuridæ having a suture-line with well individualized adventitious lobe and saddle (figs. 66a, b).

DISTRIBUTION. Upper Eo-trias. Idaho.

REMARKS. This genus retains a more rounded periphery than the other Ussurids, and the umbilicus is still open in the lectotype at a diameter of 75 mm. The immature example

figured by Hyatt and Smith on pl. lxvi, figs. 4-6 (even if of natural size [30 mm.] and not $\times 2$, as marked), shows that the peculiarities in suture-line and whorl-shape of *Metussuria* are not due to its large size, as Hyatt and Smith thought, but that they are equally pronounced in the young.

H. Family HEDENSTRÆMIIDÆ, Waagen emend.

1895, p. 142; Hyatt, 1900, in Zittel-Eastman, p. 555; J. P. Smith, 1913, p. 634.

DIAGNOSIS. Discoidal, more-or-less involute ammonites, with tabulate to oxynote venters; smooth, or with falcoid striæ of growth. Suture-lines ceratitic, with more elements than in the parallel development Paranoritidæ, and with adventitious saddles and lobes.

REMARKS. Hyatt added to the family diagnosis that the anti-siphonal lobes were bifid and very long, and the apertures provided with ventral crests—points on which there is insufficient evidence. In addition to *Hedenstræmia*, Waagen, and *Anahedenstræmia*, Hyatt, the family is here taken to include also *Clypites*, Waagen, as an independent genus; but *Cordillerites*, Hyatt and Smith, relegated by its authors to the family Pronoritidæ, is here grouped with *Pseudosagaceras*. The new genera *Parahedenstræmia* (for *Hedenstræmia acuta*, v. Krafft) and *Epihedenstræmia* (for *H. skipetarensis*, Arthaber) are sufficiently distinct from the other genera to justify separation, but a fragment described and figured by v. Krafft and Diener (1909, p. 158, pl. xxix, fig. 2) as nov. gen. ind. ex aff. *Hedenstræmia* sp. ind., and the genus *Tellerites*, Mojsisovics, can only be provisionally referred to the present family. The last was considered by Haug (1894, p. 393) to be inseparable from *Norites*, but it is not even homœomorphic with that genus.

Neither *Prodromites*, Smith and Weller, nor *Longobardites*, Mojsisovics, included in a sub-family Hedenstræminæ by Prof. J. P. Smith, are related to the true *Hedenstræmia*.

Only the genera *Anahedenstræmia* and *Tellerites* are represented in the Collection.

1. Sub-family HEDENSTRÆMIINÆ, nov.

DIAGNOSIS. Hedenstræmidæ with regular, entire saddles and ceratitic lobes and no tendency to reduction or simplification.

Genus **HEDENSTRÆMIA**, Waagen.

1895, p. 140 ; Diener, 1915, p. 147 ; 1915b, p. 31.

GENOTYPE. *Ceratites hedenstræmi*, Keyserling, 1845, p. 166, pl. ii, figs. 5-7.

DIAGNOSIS. Involute, discoidal, greatly compressed Hedenstræmidæ, with tabulate (later acute?) venter and smooth, flat sides. Suture-line ceratitic, with low and rounded adventitious and external saddles, and with the first lateral saddle at the middle of the whorl-side. Internal lobe deep and narrow, bifid.

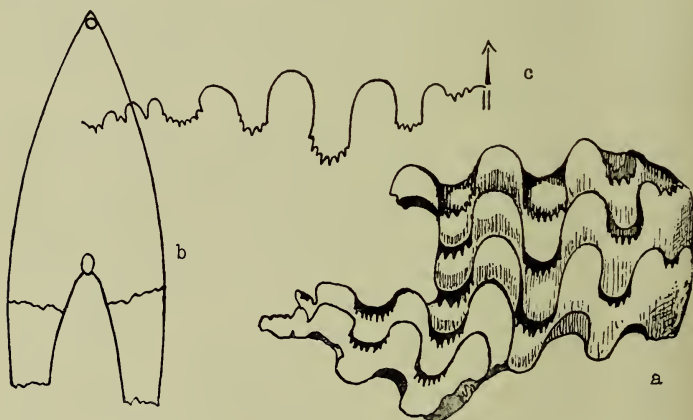


FIG. 67.—*Hedenstræmia hedenstræmi* (Keyserling). Upper Eo-trias, Columbitan?. Siberia. (After Keyserling, 1845, pl. ii, figs. 5-7, reduced to $\frac{2}{3}$ linear.)

DISTRIBUTION. Upper Eo-trias, Columbitan?. Spitsbergen ; Siberia.

REMARKS. This genus is incompletely known, being based on a fragment with, apparently, an acute venter in the adult ; no comparable forms, apart from the equally fragmentary *H. mojsisovicsi*, Diener, appear to have yet been discovered. *Anahedenstræmia* and *Clypites* differ, not only in their more linguiform outer saddles, but perhaps also in their peripheries. The acute *Parahedenstræmia* is characterized by a more individualized adventitious saddle and a less high external lobe, and is as distinct from the true *Hedenstræmia* as any of the other genera.

Genus ANAHEDENSTRÆMIA, Hyatt.

1900, in Zittel-Eastman, p. 555.

GENOTYPE. *Anahedenstræmia himalayica*, nom. nov. (= *H. mojsisovicsi*, Diener, *partim*, 1897, p. 63, pl. xx, fig. 1; 1915a, p. 148).

DIAGNOSIS. Involute, discoidal, greatly compressed Hedenstræminæ, with tabulate venter and smooth, flat sides. Suture-line ceratitic, with slender saddles and numerous generally well-individualized auxiliaries.

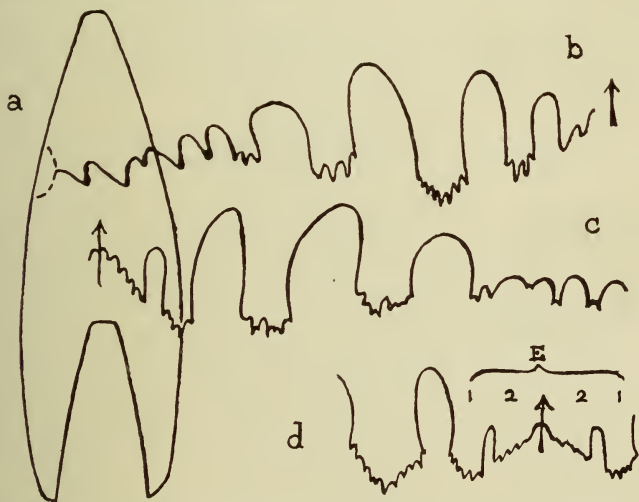


FIG. 68.—a, b, c, *Anahedenstræmia himalayica*, nom. nov. (= *Hedenstræmia mojsisovicsi*, Diener, 1897, pl. xx, figs. 1b, c, and 1915b, pl. i, fig. 8). Outline whorl-section and two external suture-lines. d, External lobe of *A. muthiana*, v. Krafft sp. (After Diener, *ibid.*, fig. 9.) Lower Eo-trias, Flemingitan ?. Himalayas.

DISTRIBUTION. Eo-trias, Upper Flemingitan to Owenitan. Himalayas, Salt Range, India; Timor; California.

REMARKS. Hyatt, when creating the genus *Anahedenstræmia*, clearly recognized that Diener's Himalayan form was not only not identical with the Siberian fragment figured by Mojsisovics (1888, p. 10, pl. ii, figs. 1a, b, pl. iii, fig. 13) as "*Meekoceras* nov. f. ind. ex aff. *M. hedenstræmi*" (the type of *Hedenstræmia mojsisovicsi*, Diener, 1915a, p. 148), and its ally, "*Ceratices*" *hedenstræmi*, Keyserling, but that it was also generically separable on account of the difference in the suture-lines. These consist of a larger number of slender saddles, often

forming, as in the somewhat similar *Pseudosageceras*, concentric spiral lines (see Pl. VI, fig. 6); and the position of the first lateral saddle is much closer to the periphery than in the Arctic forms. Altogether the suture-line of the true *Hedenstræmia* is scarcely more advanced than that of *Clypeoceras*, except in the presence of an adventitious saddle; the suture-lines of *Anahedenstræmia* and *Clypites*, on the other hand, often are complex enough to converge towards *Pseudosageceras*, especially when the lobe-bases become irregularly subdivided.

***Anahedenstræmia himalayica*, nom. nov.**

Figs. 68a-c, p. 217.

1897. *Hedenstræmia mojsisovicsi*, Diener, *partim*, p. 63, pl. xx, fig. 1 (holotype).

DIAGNOSIS. Subplatygyral, leptogyral, angustumbilicate *Anahedenstræmia*. Sides flattened, slightly convex, smooth; umbilical rim rounded, venter tabulate. Suture-line (figs. 68b, c) with linguiform saddles and smaller, variable auxiliaries.

MEASUREMENTS :

Diener, 1897, p. 63 . . . 174 . .55 . .24 . .07

REMARKS. Complete examples of this species show excentrumbilication, like the form described below as *A. evoluta*, but in this the auxiliary elements are more regular and *Pseudosageceras*-like. The restricted *Hedenstræmia mojsisovicsi* has less individualized adventitious saddles, although according to Diener, the Siberian fragment is worn and the details of the siphonal and adventitious lobes are destroyed. In spite of the fact that the Arctic forms are as yet incompletely known, it has here been considered advisable to follow Hyatt in separating them generically from the Indian species, rather than perpetuate with Diener a possible false affinity or identity by a too comprehensive interpretation.

The example in the Collection, being fragmentary and slightly crushed, also resembles *A. muthiana*, v. Krafft (in v. Krafft and Diener, 1909, p. 157, pl. ix, fig. 7), but the auxiliary lobes of this species are subdivided. The small example from Timor, listed below, is too immature to be identified specifically.

Two small examples (C. 37181-2) of an involute, discoidal form with sulcate periphery at an early stage, but flattened venter already at 20 mm. diameter, were found in the white limestone with *Anasibirites multiformis*, Welter.

They do not show a trace of the suture-line, and they are recorded here merely because Welter (1922, p. 97) listed a *Hedenstræmia* sp. ind. of the group of *H. mejsiscvicsi* from the same bed in Timor. The other Timor example listed below is from the *Kashmirites* (*Owenites*) Beds.

HORIZON AND LOCALITIES. Lower and Upper Eo-trias, Flemingitan and Owenitan. Himalayas.

SPECIMENS :

- C. 28545. South-east of Muth, Spiti. (Coll. Hayden "sub-robustus Beds.") Presented Geol. Surv. India, 1926.
 C. 34047. (Perhaps *A. waageni*, Welter sp.), ? C. 37181-2, Toeboelopo. M. E. Walsh Coll., 1930.

Anahedenstræmia evoluta, sp. nov.

Plate VI, fig. 6.

TYPE. B.M., C. 10454 (*"Hedenstræmia evolvens"*, Koken in Coll.).

DIAGNOSIS. Subplatygyral, leptogyral, angustumbilicate *Anahedenstræmia*. Sides slightly convex, umbilical slope gentle, venter tabulate; body-chamber uncoiling. Suture-line with auxiliaries more individualized and more densiseptate than in *A. himalayica*.

MEASUREMENTS :

C. 10454 . . . 190 . 48 . 16 ? . 14

REMARKS. The holotype of this species shows about half a whorl of body-chamber, and was thus of about the same size as the (less complete) type of *A. himalayica*. The umbilicus, however, is apparently larger in the form here described, with more pronounced excentrumbilication and a less distinct rim; but this may partly be due to imperfect preservation of the cast. The Salt Range form, however, figured by Frech (1905, pl. xxvii, fig. 4), and attributed to *A. himalayica*, also has an excentric umbilicus for the last half whorl, and this feature is even indicated in Diener's drawing of the type itself. There are notable differences in the suture-lines, as already indicated, but the outer (ventral) halves are closely comparable, down to the second lateral saddle. *A. kasliuensis*, Haniel sp. (1915, p. 148, pl. lvi, figs. 8a-d), has well-developed auxiliary saddles, like the present species, but a pointed external saddle and closed umbilicus. *A. waageni*, Welter sp. (1922, p. 96, pl. clv, fig. 3),

is also more involute than *A. evoluta*, and perhaps identical with *A. himalayica*; like *A. byansica* and *A. muthiana*, v. Krafft sp. (in v. Krafft and Diener, 1909, pp. 154–7, pl. viii, fig. 2, and pl. ix, fig. 7), it is said to differ in details of the suture-line.

Clypites evolvens, Waagen (1895, p. 146, pl. xxii, fig. 2), has an entirely different suture-line, but resembles the present species in its excentric umbilicus.

HORIZON AND LOCALITIES. Lower Eo-trias, Flemingitan (*flemingianus* Bed), Ceratite Sandstone. Salt Range.

SPECIMENS :

C. 10454. Virgal.

Koken Coll., purchased, 1905.

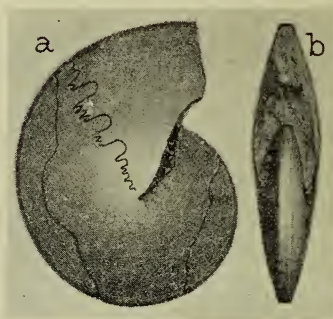


FIG. 69.—*Clypites typicus*, Waagen. Lower Eo-trias, Flemingitan. Salt Range. (After Waagen, 1895, pl. xxi, figs. 7a, b.)

Genus CLYPITES, Waagen.

1895, p. 142.

GENOTYPE. *Clypites typicus*, Waagen, 1895, p. 143, pl. xxi, fig. 7.

DIAGNOSIS. Discoidal, involute, smooth Hedenstrœminæ with tabulate venters. Suture-line as in *Anahedenstrœmia*, but with less individualized adventitious elements.

DISTRIBUTION. Lower Eo-trias, Upper Flemingitan (and Owenitan ?). Salt Range, Himalayas.

REMARKS. This genus differs from *Anahedenstrœmia* not only in its perfectly closed umbilicus, but more significantly in the suture-line, as already mentioned. Hyatt and Smith (1905, p. 103) considered that the auxiliary series of lobes and saddles was also less individualized in *Clypites* than in *Anahedenstrœmia*; but it seems to the writer that such a typical form of *Clypites* as *C. lilangensis* (v. Krafft, in v. Krafft and Diener,

1909, p. 151, pl. ix, figs. 1a-c), with the auxiliaries forming spiral lines, as in *Anahedenstræmia evoluta*, above described, can be separated much more satisfactorily on the basis of its median saddle in E and its very irregularly indented lobes.

Clypites evolvens, Waagen (1895, p. 146, pl. xxii, figs. 2a-c), was referred by Frech (1905, pl. xxiii, figs. 3a-d) to "*Aspidites*" (= *Clypeoceras*); but although Diener (1915, p. 148) listed Frech's examples in the synonymy of Waagen's species, it is probable that at least the largest of the four figured specimens represents a new form intermediate between *Clypeoceras* and *Clypites*. It is certainly not identical with *Clypeoceras evolvens* (Waagen, 1895, p. 223, pl. xxv, fig. 1), listed by Diener (1915a, p. 197) as *Meekoceras* (*Koninckites*), and it may therefore be renamed *Clypeoceras excentricum*, nom. nov. Arthaber's (1911, p. 207) objections to the separation of *Clypites* from "*Hedenstræmia*" are discounted by his describing the former genus quite erroneously as oxynote, with simple ceratitic lobes.

Genus **PARAHEDENSTRÆMIA**, nov.

GENOTYPE. *Hedenstræmia acuta*, v. Krafft, in v. Krafft and Diener, 1909, p. 157, pl. ix, fig. 2.

DIAGNOSIS. Involute, smooth, discoidal *Hedenstræmiinæ*, with oxynote periphery already developed at a small diameter. Suture-line as in *Anahedenstræmia*, with comparatively broad and short principal saddles.

DISTRIBUTION. Lower Eo-trias, Upper Flemingitan ?. Himalayas.

REMARKS. Diener correctly diagnosed this form as probably intermediate between *Hedenstræmiidæ* and the simplified *Aspenites*, just as "*Hedenstræmia*" *lilangensis* was taken to be a link between *Clypites* and *Anahedenstræmia*. Diener was not convinced of the correctness of including the form in "*Hedenstræmia*", since the acute character of the siphonal edge was associated with some other peculiarities which imparted to that species a shape differing rather considerably from the type of the genus "*Hedenstræmia*". In 1915 (a, p. 148), however, Diener again listed the present species in *Hedenstræmia*; but the evidence, even of the fragmentary material so far available, shows that a new genus is undoubtedly required.

The same may be said of the incompletely known form described by v. Krafft and Diener (1909, p. 158, pl. xxix, fig. 2) as Nov. Gen. ind. ex aff. *Hedenstræmia*. It already occurs in

the Lower Flemingitan, or even Upper Gyronitan, but has a more complex suture-line than *Anahedenstrœmia*. Moreover, it is oxynote, and was stated to show a close resemblance to *Pseudosageceras multilobatum*, Noetling. Diener considered his specimen too badly preserved for illustration, but there can be no doubt that its reference to an (unnamed) new genus was justified.

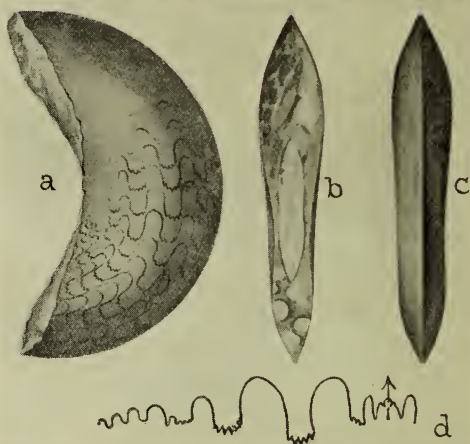


FIG. 70.—*Parahedenstrœmia acuta* (v. Krafft). Lower Eo-trias. Himalayas. (After v. Krafft and Diener, 1909, pl. ix, figs. 2a-d.)

Genus **EPIHEDENSTRÆMIA**, nov.

GENOTYPE. *Hedenstrœmia skipetarensis*, Arthaber, 1911, p. 208, pl. xvii, figs. 13a-c.

DIAGNOSIS. Involute, smooth, discoidal Hedenstrœmidæ, with tabulate, comparatively broad venter. Suture-line with primitive saddles and lobes, but well separated adventitious and numerous auxiliary elements and general high curvature.

DISTRIBUTION. Upper Eo-trias, Columbitan ?. Albania.

REMARKS. Arthaber observed that, strictly speaking, a new generic name should be given to a form of such peculiar characters, and he refrained from doing so merely because only a single small example was available for study. There can be no doubt, however, that if the suture-line is at all correctly drawn, the Albanian form cannot be accommodated in any of the known genera of Hedenstrœmidæ. In any case the wide

external lobe with its distinct adventitious elements and the curvature of the suture-line cannot have suffered in the preparation, even if the simple outlines of the numerous saddles and lobes should be due to excessive abrasion. The distinct ventro-lateral ridges, as Arthaber points out, cause a curious resemblance of the present form to the Anisian genus *Norites*.

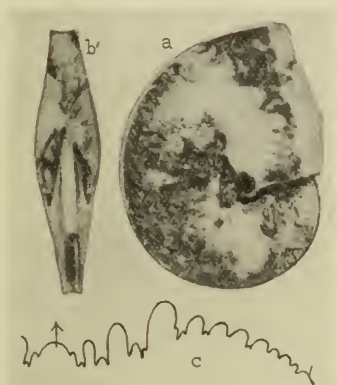


FIG. 71.—*Epihedenstræmia skipetarensis* (Arthaber). Upper Eo-trias, Columbitan ?. Albania. (After Arthaber, 1911, pl. xvii, figs. 13a-c.)

Genus **METAHEDENSTRÆMIA**, nov.

GENOTYPE. *Hedenstræmia kastriotæ*, Arthaber, 1911, p. 208, pl. xvii, figs. 14a-c.¹

DIAGNOSIS. Involute smooth, discoidal Hedenstræmidæ, with very narrowly tabulate venter. Greatly compressed; whorls almost flat, with faint flexistriæ. Suture-line with small adventitious and well-individualized auxiliary saddles.

DISTRIBUTION. Upper Eo-trias, Columbitan ?. Albania.

REMARKS. Arthaber considered that *M. kastriotæ* in its slender whorl-shape was connected with the involute *Clypites* of the Salt Range rather than with the more evolute Himalayan forms of *Anahedenstræmia*, which it resembled in the degree of evolution of its suture-line. The latter has an adventitious lobe, definitely separated from the external lobe by a saddle, as in *Anahedenstræmia*; but the shortness of the external lobe, the plumpness of the principal and comparatively large size of the auxiliary saddles, and the shape of the indentations of the

¹ Represented by a single, imperfect example (C. 22864).

lobes, are all such peculiar features that the separation of the present genus is well justified.



FIG. 72.—*Metahedenstræmia kastriotæ* (Arthaber). Upper Eo-trias, Columbitan ?. Albania. (After Arthaber, 1911, pl. xvii, figs. 14a-c.)

Genus **TELLERITES**, Mojsisovics.

1902, p. 311 ; Diener, 1915a, p. 272 ; 1915b, p. 44.

GENOTYPE. *Ceratites furcatus*, Öberg, 1877, p. 13, pl. iii, figs. 6a-c.

DIAGNOSIS. Discoidal, involute Hedenstræmidæ with sulcate periphery bordered by two keels, and indistinct sigmoidal ribbing on sides. Suture-line ceratitic, with small adventitious saddles.

DISTRIBUTION. Upper Eo-trias, Columbitan ?. Spitsbergen.

REMARKS. The general resemblance of *Tellerites* to forms of the group of "*Meekoceras*" *sibiricum*, Mojsisovics, to some Prionitids, and to *Arctoprionites*, described below, makes it doubtful whether the presumed affinity with *Hedenstræmia* is so close as is suggested by Mojsisovics's statement that *T. furcatus* might be merely the young of *Hedenstræmia hedenstræmi*. The small form described below, with its deeply channelled periphery, is quite unlike any other Lower Triassic form recorded.

Tellerites sp. juv. aff. *furcatus* (Öberg).

Plate VI, fig. 3 ; text-fig. 73e.

1921, Spath, Geol. Mag., p. 301.

DIAGNOSIS. Platygyral, subpachygyral, angustumbilicate *Tellerites*. Suture-line not shown. The last third of a whorl (at 10 mm. diameter) is apparently already the body-chamber.

REMARKS. This small example was previously described as "probably belonging to a new form of *Tellerites*, but slightly malformed". The deeply sulcate periphery shows an irregular curve, caused by accident or deformity, but it is quite possible that the specimen is specifically identical with Öberg's smaller example, especially since it is known that the young of many ammonites may be extraordinarily variable when the adults are indistinguishable. There is slight sigmoidal costation, as in the typical forms, but the umbilical wall is not yet so high nor the inner lateral area so bulging as in the larger example figured by Mojsisovics (1886, p. 80, pl. x, fig. 18). Since the example

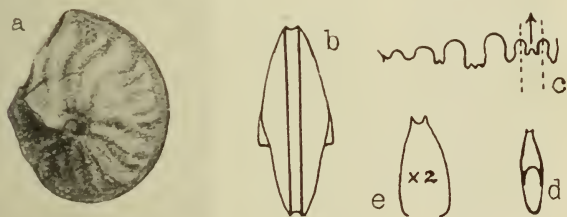


FIG. 73.—*Tellerites furcatus* (Öberg). Upper Eo-trias. Spitsbergen. a-d, Adapted from Mojsisovics, 1886, pl. x, figs. 18a, b, 19c and b. e, Diagrammatic whorl-section (enlarged $\times 2$) of the examples of *T. sp. juv. aff. furcatus*, here described.

may be an immature individual rather than a micromorph, it does not seem advisable to separate it from the typical *T. furcatus* merely on the strength of its deeper siphonal channel. "*Tellerites*" *oxynotum*, Frebold (1930, p. 22, pl. iv, figs. 4, 4a), does not appear to belong to the present genus, but the same author's *Pseudosageceras grippi* (1929a, p. 298, pl. i (36), fig. 2) has a bicarinate periphery, like the specimen here described. In the absence of the suture-line definite identification is difficult, but *Pseudosageceras multilobatum*, Noetling (in J. P. Smith, 1932, pl. xxv, figs. 10, 11), at the same size, has a truncate venter and seems quite different from *Tellerites furcatus*.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?. Trident, Sassendal, Spitsbergen.

SPECIMENS :

C. 26940.

J. W. Gregory Coll., 1896.

2. Sub-family LANCEOLITINÆ, nov.

DIAGNOSIS. Involute, smooth, discoidal Hedenstroemidæ with tabulate venter and flat whorl-sides. Suture-line ammonitic, irregular; wide, but high, E with indistinct adventitious elements.

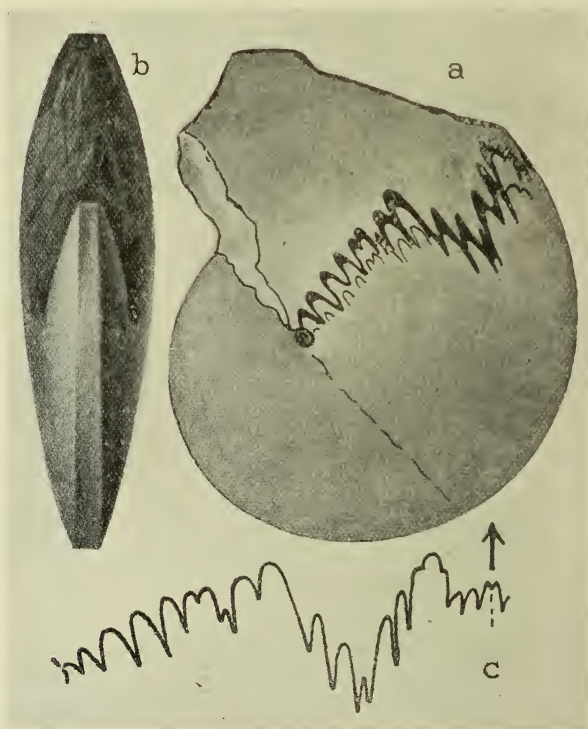


FIG. 74.—*Lanceolites compactus*, Hyatt and Smith. Upper Eo-trias, Meekoceras Beds. California. (After Hyatt and Smith, 1905, pl. lxxviii, figs. 9–11; c, enlarged $\times 1\frac{1}{2}$.)

REMARKS. Hyatt and Smith included *Lanceolites* with *Cor-dillerites* in the Pronoritidæ, but the resemblance of these genera, shown by their lanceolate suture-lines, is confined to the adult, and quite superficial. Arthaber (1911, p. 212) had been doubtful whether *Lanceolites* ought to be included in Carnitidæ, but in 1913 (p. 635) Prof. J. P. Smith definitely listed *Lanceolites* as a Carnitid, together with an heterogeneous assemblage of

other genera. In 1927 (p. 72) he included it with the unrelated Anisian genus *Arthaberites* in a family Hauericeratidæ, based on a somewhat homœomorphous, but widely distinct, Upper Triassic genus. It is probable that *Lanceolites* is a modified (reduced?) Hedenstrøemid, similar to certain specialized Meekoceratids (Dagnoceratids); and that the larger number of auxiliaries is partly due to the increased width of the whorls. In view of its peculiarly specialized suture-line, *Lanceolites* may be separated in an independent sub-family.

Genus LANCEOLITES, Hyatt and Smith.

1905, p. 113; Diener, 1915*a*, p. 181; 1915*b*, p. 38.

GENOTYPE. *L. compactus*, Hyatt and Smith, 1905, p. 113, pl. lxxviii, figs. 9-11 (lectotype); pl. iv, figs. 4-10; pl. v, figs. 7-9.

DIAGNOSIS. As for the sub-family.

DISTRIBUTION. Upper Eo-trias, Owenitan (= Meekoceratan). Idaho; California.

REMARKS. The lanceolate suture-line which, according to Hyatt and Smith, is characteristic of maturity in this genus, arises from a comparatively simple type (see pl. iv, fig. 10) with rounded external saddles. Even if, contrary to Diener, we allow that there are adventitious elements in E, the development of the suture-line is obviously quite different from that found in Hedenstrøemiinæ.

3. Sub-family ASPENITINÆ, nov.

DIAGNOSIS. Discoidal, involute Hedenstrøemidæ, with acute or oxynote venters and almost goniatitic suture-lines, with numerous elements and adventitious lobes.

REMARKS. Hyatt and Smith (1905, p. 95) first included *Aspenites* with *Clypites*, *Hedenstrœmia* and *Pseudosayeceras*, in the family Pinacoceratidæ; Arthaber (1911, p. 185) referred it to Prodromitidæ, and in 1913 Prof. J. P. Smith (p. 634) included *Aspenites* in Hedenstrøemiinæ. Diener (1915*b*, p. 35), however, has shown that, as in the case of the other Hedenstrøemids, the ancestor of *Aspenites* can only have been a form of the genus "*Meekoceras*" (*sensu lato*). *Beatites*, Arthaber, as Diener thinks, may not have adventitious elements in its suture-line; but, considering the simplification of the lobes and saddles shown in *Aspenites acutus*, Hyatt and Smith, as compared with *Aspenites lævis*, Welter, it is not impossible that further reduction in an Aspenitid stock may have given rise to the goniatitic

suture-line of *Beatites*. The inclusion of this genus in the present family, however, is provisional; so is the separation of the genus *Pseudaspenites* nov. (for *Aspenites layeriformis*, Welter), in which the curvature of the suture-line is strikingly different, though otherwise there is agreement with true *Aspenites*. The genus *Parahedenstroemia* connects the present sub-family with Hedenstroeminae.

Genus **ASPENITES**, Hyatt and Smith.

1905, p. 95; Diener, 1915*a*, p. 59; 1915*b*, p. 34.

GENOTYPE. *Aspenites acutus*, Hyatt and Smith, 1905, p. 96, pl. ii, figs. 9-13; pl. iii, figs. 1-5.

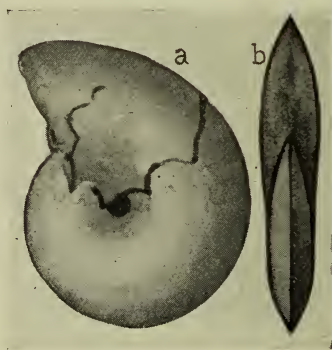


FIG. 75.—*Aspenites acutus*, Hyatt and Smith. Upper Eo-trias. Idaho, U.S.A. (After Hyatt and Smith, 1905, pl. iii, figs. 1, 2, holotype.)

DIAGNOSIS. Compressed, involute, discoidal Aspenitinae, with flattened sides and oxynote venter. Smooth or with fine, strong radial folds. Suture-line ceratitic, with small adventitious lobes and a series of goniatic auxiliaries.

DISTRIBUTION. Upper Eo-trias, Lower Owenitan (= Meekoceratan). Idaho; Timor.

REMARKS. The less simplified species from Timor, *Aspenites laevis*, Welter, with almost a *Parahedenstroemia* suture-line, may be slightly earlier than the typical Idaho form. It is, of course, quite unsafe to attempt to deduce geological age from the stage of complication of the suture-line, but the general aspect of the accompanying fauna may be relied on. J. P. Smith's *A.*

lævis (non Welter, 1932, p. 86, pl. xxviii, figs. 28-33) is a misidentified *Pseudosageceras*.

***Aspenites acutus*, Hyatt and Smith.**

1905, pp. 95, 96, pl. iii, figs. 1, 2 (holotype).

DIAGNOSIS. Platygyral, subleptogyral, perangustumbilicate *Aspenites*; venter oxynote, whorl-sides flattened, with indistinct folds. Suture-line as stated in generic diagnosis.

REMARKS. In two of the examples (casts) of the present species the fine radial folds described by Hyatt and Smith are visible, being stronger near the umbilicus and becoming obsolete high up on the flanks. In these two examples there is also a distinct spiral ridge, so that apart from the closed umbilicus

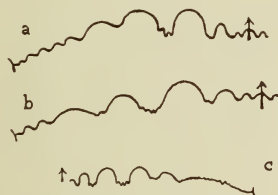


FIG. 76.—*Aspenites acutus*, Hyatt and Smith. Upper Eo-trias. Idaho, U.S.A. *a*, *b*, After Hyatt and Smith, 1905, pl. ii, figs. 11, 13. *c*, From specimen C. 21862, showing curvature of auxiliaries.

(and different suture-line) there is great resemblance in lateral aspect to *Pseudaspenites layeriformis* (Welter). The ornamentation of *Aspenites acutus* is of a type common in the Lower Liassic *Oxynoticeras* (*i. e.* *O. wingravei*, Spath).

Aspenites lævis, Welter (1922, p. 99, pl. clv, figs. 4, 5), is smooth, and has a less reduced suture-line than *A. acutus*; it is interesting on account of its being transitional to Hedenströemids (*Parahedenströemia*).

HORIZON AND LOCALITIES. Middle Eo-trias, Lower Owenitan (= Meekoceratan). Aspen Mountains, near Bear Lake, S.E. Idaho, U.S.A.

SPECIMENS :

C. 21861-3.

Presented Dr. C. T. Trechmann, 1920 (ex

J. Perrin Smith Coll.).

Genus **PSEUDASPENITES**, nov.

GENOTYPE. *Aspenites layeriformis*, Welter, 1922, p. 97, pl. clv, figs. 6-8.

DIAGNOSIS. Discoidal, compressed Aspenitinæ, like *Aspenites*, but with the umbilicus open, the suture-line with peculiar curvature and more numerous auxiliaries.

DISTRIBUTION. Upper Eo-trias, Lower Owenitan (= Meekoceratan). Timor.



FIG. 77.—*Pseudaspenites layeriformis* (Welter). Upper Eo-trias. Timor. (After Welter, 1922, pl. clv, figs. 6-8.)

REMARKS. This form is not so closely allied to *Aspenites acutus* as Welter or J. P. Smith (1932, p. 86) were inclined to think. There are twice as many auxiliaries in the Timor species in spite of an open umbilicus; and they are not reduced to a mere wavy line, but are well individualized, if somewhat irregular. The auxiliaries, also, are not convex forwards. In immature *Aspenites acutus*, again, the wide and large second lateral saddle and the similar but longer curve of the scarcely notched auxiliaries (see fig. 76c) are very striking. In *P. layeriformis*, on the other hand, the auxiliaries form a curve in

the opposite direction, with very conspicuous umbilical projection. The differences in ornamentation are, perhaps, unimportant, in view of the type of ribbing noticed above in two examples of the Californian species.

It might be held that the differences in suture line between *Aspenites acutus* and *A. lævis* are more striking than those between the lobes of *Aspenites* and *Pseudaspenites*; but in the writer's opinion these differences are not of equal systematic importance.

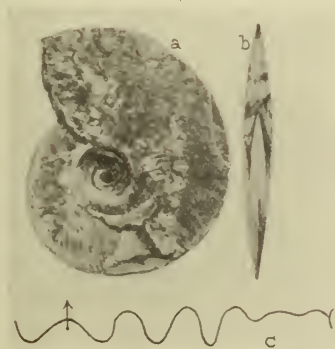


FIG. 78.—*Beatites berthæ*, Arthaber. Upper Eo-trias, Columbitan ?. Albania. (After Arthaber, 1911, pl. xvii, figs. 15a-c.)

? Genus **BEATITES**, Arthaber.

1911, p. 210; Diener, 1915a, p. 66; 1915b, p. 31; Welter, 1922, p. 98.

GENOTYPE. *Beatites berthæ*, Arthaber, 1911, p. 210, pl. xvii, fig. 15.

DIAGNOSIS. Discoidal, greatly compressed and comparatively evolute Aspenitinae with oxynote venter. Whorl-sides flat, with curved, slightly rursiradiate, striae of growth. Suture-line goniatitic, with wide E and two more principal lobes which may be either E and L (if the saddle between be adventitious) or L and L₂. Ontogenetic development unknown.

DISTRIBUTION. Upper Eo-trias, Columbitan ?. Albania.

REMARKS. Arthaber considered that *Beatites*, in its sutural line, was closely comparable only to the genus *Aspenites*. If the very peculiar, clydonitic lobes and saddles of *Beatites* are the result of reduction, this comparison may be more apt than Diener thinks, and for this reason Arthaber's genus is here provisionally classed with Aspenitinae. The resemblance to

Pompeckjites layeri (Hauer) is superficial, and *Beatites* must be considered a reduced end-form, even as regards the adventitious elements of its suture-line, and not an ancestor or precursor of the later Pinacoceratids.

INCERTÆ SEDIS.

4. Sub-family BENECKEINÆ, Waagen.

1895, p. 141.

DIAGNOSIS. Involute, smooth, oxycone Hedenstrœmidæ with entire, multilobate suture-lines, with small adventitious lobes.

DISTRIBUTION. Upper Eo-trias to Meso-trias (Bunter [Röth] and Muschelkalk).

REMARKS. Waagen, when creating the sub-family Beneckeinae, thought it doubtful whether the characters of the two genera included in it (*Beneckeia* and *Longobardites*) were sufficiently different from those of Hedenstrœminæ to warrant their separation as a sub-family. Waagen, however, considered them to be of different ancestry, and also took the presence of one adventitious lobe to be characteristic.

Longobardites, Mojsisovics, is not here included in the same family with *Beneckeia*, since it is believed to be a derivative of *Hungarites*, as suggested by J. Perrin Smith. *Beneckeia* has small adventitious lobes, which, according to Diener (1915*b*, p. 42), are variable "probably because they may be in process of formation". Whether Beneckeinae could be reduced Hedenstrœmids, with the lobes entire owing to simplification, is doubtful; but this might explain the similarity to Cretaceous Pseudoceratites of the doubtful Transjordanian form figured by Cox (1924, p. 88, pl. ii, figs. 16*a*, *b*). The genus *Beneckeia* was, however, included in the Hungaritidæ in Zittel's Text-book (1913, p. 646), and in the Ceratitidæ in the sixth German edition (1924, p. 555); whereas Haug attached it provisionally to Meekoceratidæ. Frech believed it to be derived from "*Lecanites*"; but Fritsch (1902, p. 52) pointed out that its three primitive characteristics, namely, the deep hyponomic sinus, the goniatitic suture-lines, and the internal position of the siphuncle, made it impossible to connect *Beneckeia* with any of these younger, not to say more highly developed stocks.

The two Transjordanian fragments above referred to (B.M., C. 25231-2) are unfortunately too incomplete and too weathered to be definitely identified; and I previously stated (in Cox, p. 88) that the very peculiar shape (see fig. 79*f*) of the

external part of the suture-line (external and adventitious lobes) suggested comparison with certain Cretaceous Pseudoceratites, *e.g.* Engonoceratids. The suture-line of such a form as *Neolobites choffati*, Hyatt (1903, pl. xxv, fig. 3), has a similar deep and narrow lateral lobe, adventitious elements, and broad, flat-topped auxiliary saddles; and the presence of an oxynote, instead of a tabulate, periphery might not be of more than

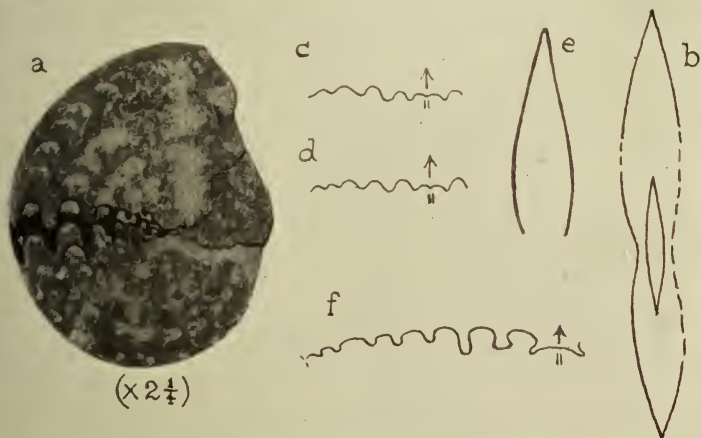


FIG. 79.—*a*, *Beneckeia buchi* (Alberti), Quenstedt sp. "Mittleres Wellengebirge," Belzloch, near Güttingen, Wurtemberg. (After M. Schmidt, 1907, pl. ii, fig. 2, enlarged $\times 2\frac{1}{4}$.) *b-d*, *Beneckeia tenuis* (Seebach). Outline whorl-section (after Wagner, 1888, pl. v, fig. 2) and external suture-lines of two examples (after Mojsisovics, 1882, pl. lxi, figs. 9, 10). *e*, *f*, *Beneckeia* ?, sp. nov. Outline whorl-section and suture-line of the Transjordan example (B.M., C. 25231) discussed above (p. 232).

specific importance. It will be seen that the external portion of the suture-line of *B. buchi*, as drawn by Philippi (in Frech, 'Lethæa Geogn.', II, i, 1903, pl. i, fig. 6c), though also showing a small adventitious saddle, differs considerably from the corresponding parts in the Palestine form. The latter thus probably represents an entirely new development. A larger fragment (C. 34858) found later at a locality 3 km. south of Tel Rameh, Wadi Hisban, Transjordan, and presented by G. S. Blake in 1930, unfortunately is also incompletely preserved, but septate to about 100 mm.

Genus **BENECKEIA**, Mojsisovics.

1882, July, p. 183, *non Beneckeia*, Uhlig, June, 1882 = *Silesites*, Uhlig, 1883. (Irregular, but should be standardized.)

GENOTYPE. *Ammonites buchi* (Alberti), Quenstedt, 1849, pl. iii, fig. 12.

DIAGNOSIS AND DISTRIBUTION. As for the sub-family.

REMARKS. The only Eo-triassic form known is *B. tenuis* (Seebach); but three Muschelkalk species have been described, of which one (*B. denticulata*, Fritsch) has toothed lobes. If the early form be a reduced Hedenstrœmid, it is almost certain that the Muschelkalk species, with constricted young, are not its descendants, but are (simplified?) derivatives of another stock, with denticulation lost in two species (*B. buchi* and *B. wogauana*?), but not in the third. *B. wogauana*, however, is said to be intermediate between *B. tenuis* and *B. buchi*, which species alone are represented in the Collection; and it is possible that they are all derived from a primitive "*Lecanites*" stock with entire goniatitic suture-lines, which may have persisted throughout, *i.e.*, their resemblance to Hedenstrœmidæ is merely a case of homœomorphy, as is the similarity of *Norites* to *Tellerites*.

Beneckeia tenuis (Seebach).

1857, p. 24; 1861, p. 650, pl. xv, fig. 11 (*Goniatites*); Diener, 1915*a*, p. 66; 1915*b*, p. 42; 1925, p. 85; Assmann, 1926, p. 526; M. Schmidt, 1928, p. 289; Kutassy, 1933, p. 435.

DIAGNOSIS. Platygyral, leptogyral, perangustumbilicate *Beneckeia*. Sides flat and smooth, periphery oxynote. Suture-line with six shallow lobes, first of which is as wide as the external and first lateral saddles (fig. 79*c, d*).

MEASUREMENTS :

C. 27469 (Jena)	.	.	.	83	·54	·13?	·03?
Wagner, 1888, pl. v, fig. 2	.	.	.	65	·55	·15?	·02?
Fritsch (1904, p. 45)	.	.	.	100-150	—	·17	—

REMARKS. Owing to the defective preservation of nearly all the examples, the whorl-thickness seems to vary considerably; but, according to Fritsch, in the adult it scarcely exceeds one-sixth of the diameter. *B. buchi* differs from *B. tenuis* in its suture-line, as does the doubtful new form from Transjordan, above referred to.

HORIZON AND LOCALITIES. Upper Eo-trias, Lower Rôth (Bunter). Germany.

SPECIMENS :

C. 27468-9. Jena, Thuringia.

Purchased, 1926.

C. 31403. Same locality.

Purchased, 1928.**Beneckeia buchi** (Alberti), Quenstedt sp.

1849, p. 70, pl. iii, fig. 12 (*Ammonites*); M. Schmidt, 1907, p. 83, pl. ii, figs. 1-3; Diener, 1915*a*, p. 66; 1915*b*, p. 42; 1925, p. 85, text-fig. 22; Assmann, 1926, p. 526; M. Schmidt, 1928, p. 288; Kutassy, 1933, p. 435.

DIAGNOSIS. *Beneckeia* like *B. tenuis*, but the suture-line with more numerous (especially inner) lobes, all narrower than the intervening saddles (see fig. 79*a*).

MEASUREMENTS :

Fritsch (1902, pl. iv, fig. 11)	.	40	.56	?	.03?
„ (<i>ibid.</i> , p. 50)	.	—	—	.20	—

REMARKS. The usual small examples with rounded venter cannot generally be dissected back to the innermost whorl on account of imperfect pyritization. As Fritsch pointed out, all the discoidal forms found at Rottweil and other localities in the Black Forest have been referred to this species, and may include similar pyritized young of other discoidal genera. If these were known, it might be possible to state more definitely whether *B. buchi* is closer to the Eo-triassic *B. tenuis* than to contemporary genera, such as reduced *Ceratitids*.

B. vogauana (H. v. Meyer), Fritsch (1902, p. 47, pl. iv, fig. 1), is distinguished from *B. buchi* chiefly by its lobes, which are transitional between those of *B. buchi* and *B. tenuis*. The rare *B. denticulata*, Fritsch (1902, p. 48), has toothed lobes; and the Transjordanian *B?* sp. above mentioned has a smaller external saddle and a deep lateral lobe.

HORIZON AND LOCALITIES. Middle Trias, Lower Muschelkalk (Wellenkalk). Germany.

SPECIMENS :

C. 14067-8. Leimen, near Heidelberg, Baden.

Purchased, 1911.

C. 31401-2. Zwätzen, near Jena, Germany.

Purchased, 1928.

The Collection also includes the cast of a body-chamber example (from the Unteres Wellengebirge of Freudenstadt) in the Stuttgart Museum (C. 31326).

I. Family KASHMIRITIDÆ, nov.

DIAGNOSIS. Costate developments of a stock similar to primitive Flemingitids or Xenoceltitids tending to peripheral ribbing, as in *Anasibirites*, or to carination.

REMARKS. The four genera here comprised in the family Kashmiritidæ are very closely connected, but a different grouping might have been affected by including *Anakashmirites* with *Xenodiscoides* (Flemingitidæ); associating *Pseudoceltites*, and especially *Kashmirites*, with *Anasibirites*, as Hyatt did, and separating from them the doubtful, keeled genus *Hanielites*. It is, however, just the difficulty of placing this last development that makes it advisable to keep together in one systematic unit *Hanielites* and *Kashmirites*; and the other genera naturally follow. Moreover, *Anasibirites* shows closer affinity than do the other Kashmiritid genera with the Stephanitids, and especially the Prionitids, discussed below; it seems more appropriately included in the family Sibiritidæ, which is dealt with after the remaining Meekoceratid families, and the Prionitids, so as not to separate them from Stephanitids and the Acrochordiceratidæ of Anisian age.

Genus ANAKASHMIRITES, Spath.

1930, pp. 35, 89.

GENOTYPE. *A. nivalis* (Diener), Pl. XII, figs. 4c, d (a, b), identified with *Danubites nivalis*, Diener, 1897, p. 51, pl. xv, figs. 17-19, and *Xenodiscus nivalis*, v. Krafft and Diener, 1909, p. 102, pl. xxiv, figs. 1-3, 5; pl. xxv, fig. 5.

DIAGNOSIS. Evolute, serpenticone Kashmiritidæ, with ribs tending to thicken towards ventro-lateral borders, and widely arched peripheries. Suture-line with low external lobe and large external saddle.

DISTRIBUTION. Middle Eo-trias, Flemingitan and Owenitan. Himalayas; Timor.

REMARKS. Diener in 1897 (p. 26) grouped his forms of *Danubites* into three divisions, the first two of which comprised various costate offshoots (including *Glyptophiceras* from the lowest Eo-trias), united merely on account of persistence or decline of costation, respectively—obviously a most unsatisfactory character for systematic purposes, although used so frequently in Ammonoid classifications. The third section,

comprising only "*Danubites*" *nivalis*, was stated to be distinguished by a very peculiar sculpture recalling somewhat that of *Tirolites*. These divisions were emended in 1909 (p. 91), and the doubtful "*Xenodiscus*" *asiaticus*, v. Krafft, was then added to the "group of *Xenodiscus nivalis*". A. v. Krafft, in the same work (p. 103), however, clearly recognized that *Xenodiscus nivalis* was very nearly allied to *Dinarites coronatus*, Waagen. The latter is probably a young *Kashmirites*; but the typical costation and peripheral ribbing in that genus appear only at larger diameters, when the whorl-shape also becomes different from that of large *Anakashmirites* (compare such forms as *Xenodiscus* sp. nov. ind. ex aff. *nivalis*, Diener, in v. Krafft and Diener, 1909, p. 103, pl. xxiv, fig. 4). Welter (1922, pl. clix), however, has figured several Timor forms of "*Xenodiscus*" that are intermediate between *Anakashmirites* and *Kashmirites*, and come from beds in which *Pseudoflemingites* is dominant.

It is interesting to note that v. Krafft's *Tirolites asiaticus*, referred by Diener to "*Xenodiscus*" (in v. Krafft and Diener, 1909, p. 105, pl. xxvi, fig. 5), was not only considered to be related to "*Danubites*" *nivalis*, but was also compared to *Tirolitoides*, described below. It is suggested on p. 384 that Dinaritids (and with them Tirolitids) may be descendants of a *Dieneroceras*-like, persisting, radical; and that then the numerous cases of convergence shown in the successive costate offshoots, or in Kashmiritidæ and the Flemingitids, become explicable. Ammonites are far too homogeneous a group to be easily subdivided into families, but it seems preferable to make an attempt than to revert to a mere alphabetical listing of genera.

Anakashmirites nivalis (Diener).

Plate XII, figs. 4a-e.

1897, p. 51, pl. xv, figs. 17-19 (*Danubites*); 1909, p. 102, pl. xxiv, figs. 1-3, 5; pl. xxv, fig. 5; 1915a, p. 313; Welter, 1922, p. 107, pl. clix, figs. 19, 20 (*Xenodiscus*); Kutassy, 1933, p. 708.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate to latumbilicate *Anakashmirites*; whorl-section rounded, depressed (and constricted) in young only, with broadly arched venter; broad radial folds, seven to twelve in a whorl, declining to striation on the body-chamber or even earlier. Suture-line ceratitic, with deep, bifid external lobe (Pl. XII, fig. 4e).

MEASUREMENTS :

Diener, 1897, p. 51	28	·29	·29	·50
v. Krafft and Diener, 1909, p. 102				
(No. II)	22	·32	·32	·45
„ „ (No. III)	38	·30	·26	·47
Welter, 1922, p. 107	27	·22-·26	·33	·48
C. 28542 (Pl. XII, figs. 4a, b)	50	·26	·26	·50
C. 28543 (Pl. XII, figs. 4c, d)	33	·30	·34	·50

REMARKS. This variable species is connected by transitions with forms like *A. kapila*, Diener sp. (in v. Krafft and Diener, 1909, p. 99, pl. xxvii, figs. 2, 3), and *A. lidacensis* and *A. involutor* (Welter, 1922, pp. 108-9, pl. clix, figs. 5-7, 18, and figs. 11, 12), which lead to the true *Kashmirites*. On the other hand, *A. ? purusha*, Diener sp. (1897, p. 30, pl. xv, figs. 14, 15), seems to be transitional to *Xenodiscoides* in its slender saddles, although it has a deeper external lobe than the more typical *Xenodiscoides*. The Salt Range *A. ? radiosus* (Koken MS.), Frech sp. (in Noetling, 1905, pl. xxii, figs. 1a-c) and *A. ? fortis* (*ibid.*, figs. 2a, b) differ in whorl-section and ribbing.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan (= Meekoceratan). Himalayas; Timor.

SPECIMENS :

C. 28542-4. Jolinka, Byans, Himalayas.

Presented, Geol. Surv. of India, 1926.

Anakashmirites brouweri (Welter).

1922, p. 110, pl. clix, figs. 14-16 (holotype).

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Anakashmirites*. Whorl-section depressed, with evenly arched, smooth venter and rounded umbilical slope. Blunt bulges on inner whorls, passing into more distinct, rursiradiate ribs on body-chambers. Suture-lines ceratitic, with comparatively large external saddle.

MEASUREMENTS :

Welter, p. 110	35	·29	·31	·43
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REMARKS. This species is represented by a number of individuals that show great variability. In some the inner whorls are almost smooth to a considerable diameter, and in others the earlier, blunt ribs are closer, and give rise to true ribs at a smaller diameter than in the typical forms. There are also

various transitions to the forms described by Welter as *Xenodiscus lidacensis*, *X. bittneri* (non Hyatt and Smith), and *X. oyensi*, Welter (1922, pls. clviii and clix).

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan. Timor.

SPECIMENS :

C. 33758-62, 33763-89. Toeboelopo, Timor.

M. E. Walsh Coll., 1930.

C. 33790-94. Nifoekoko, Timor.

Same Coll.

C. 34048. (var.) Nifoekoko, Timor.

Same Coll.



FIG. 80.—*Pseudoceltites multiplicatus* (Waagen). Side- and peripheral views and suture-line of holotype from the Upper Ceratite Limestone of Koofri, Salt Range. (After Waagen, 1895, pl. vii, figs. 2a-c.)

Genus PSEUDOCELTITES, Hyatt.

1900, p. 558.

GENOTYPE. *Celtites multiplicatus*, Waagen, 1895, p. 78, pl. vii, fig. 2.

DIAGNOSIS. More-or-less evolute Kashmiritidæ with costation tending to be prominent at the periphero-lateral angles, and with the ventral area more arched and smoother than in *Kashmirites*. Suture-line ceratitic, with only two lateral lobes.

DISTRIBUTION. Upper Eo-trias, "Upper Ceratite Limestone". Salt Range.

REMARKS. When founding the genus *Kashmirites*, Diener (1913) apparently overlooked Hyatt's genus *Pseudoceltites*, which also was omitted in the Catalogues (1915 and 1933), where Diener and later Kutassy included the genotype, namely, Waagen's *Celtites multiplicatus*, in the genus *Kashmirites*. Authors are agreed that *Celtites multiplicatus* and *C. armatus*,

Waagen, the genotype of *Kashmirites*, are very closely allied. If we here keep the two genera separate, it is done mainly because such characteristic species of *Kashmirites* as *K. blaschkei*, Diener, here figured (fig. 81) with costate, subtabulate periphery and almost rectangular whorl-section, are sufficiently different from the type of *Pseudoceltites* for generic distinction. Moreover, according to Waagen, the two Salt Range species come from quite different beds. Although *Kashmirites armatus* thus appears to be merely a less compressed *Pseudoceltites multiplicatus*, and seems to be transitional from this apparently more primitive form to the more specialized *Kashmirites* of the *blaschkei*-type, it is yet possible that the similarity is only superficial, and that the later *Pseudoceltites* is in reality a heterochronous homœomorph of the earlier primitive Kashmiritids. In any case it is too incompletely known to be definitely identified with *Kashmirites*, and its horizon, as given by Waagen, may also require correction.

Arthaber (1911, p. 228) gave a new name to the genotype, including it in the genus *Xenodiscus*, here restricted to Permian forms. There is danger of confusing *Pseudoceltites* with the group of the Siberian *Ceratites multiplicatus*, Mojsisovics, referred to above (as "obsoleti", p. 126) under *Xenoceltitidæ*; but since they are now referred to different genera, Arthaber's name is not considered necessary.

Genus KASHMIRITES, Diener.

1913, p. 33 ; 1915a, p. 177 ; Welter, 1922, p. 120.

GENOTYPE. *Celtites armatus*, Waagen, 1895, p. 75, pl. vii, figs. 1 and 7.

DIAGNOSIS. More-or-less evolute, quadrate-whorled Kashmiritidæ, with strong, often almost tuberculate ribbing on inner, degenerating into striation on the outer, whorls. Subtabulate, wide, peripheries, often with the costation continuous across them. Suture-line simple, ceratitic, generally with only two lateral lobes.

DISTRIBUTION. Upper Eo-trias, Owenitan (and Columbitan ?). Salt Range ; Kashmir ; Timor.

REMARKS. It has already been mentioned that some of the Salt Range species listed by Diener (e.g. *Celtites dimorphus* and *C. subrectangularis*, Waagen) are transitional between *Kashmirites* and *Pseudoceltites*. The Timor species described by Welter are, however, typical *Kashmirites*. The length of the body-chamber is too variable a feature to be used for systematic

purposes, and even if quite considerable differences of length were found to exist among the Salt Range, Himalayan, and Timor species, they would not prevent their reference to the same genus.

It is interesting to note that no true *Kashmirites* is known from California, where *Owenites* Beds are also developed.



FIG. 81.—a, b, *Kashmirites blaschkei*, Diener. Side- and peripheral views of a complete specimen, and c, suture-line of a smaller example. d, *K. subarmatus*, Diener. Portion of suture-line. e, *K. sp. ind. aff. lævigato* (Waagen) Diener. External suture-line. All from Lower Trias of Guryul Ravine, Kashmir. (After Diener, 1913, pl. iii, figs. 11a, b, 12c; pl. v, figs. 3b, 6d.)

Kashmirites subrobustus, Welter.

1922, p. 121, pl. clxiii, figs. 13–15.

DIAGNOSIS. Substenogyral to subplatygyral, subpachygyral, sublatumbilicate *Kashmirites*. Whorl-section subquadrate, with greatest thickness at umbilical border, and slightly rounded, smooth, tabulate venter. Sides flattened, umbilical wall high and perpendicular. Coarse, radial folds in young, degenerating

into irregular striæ on body-chamber. Suture-line ceratitic, with only the first lateral lobe toothed.

MEASUREMENTS :

Welter, p. 122	.	.	52	.	·31	.	·37	.	·40
C. 33750	.	.	53	.	·37	.	·39	.	·36

REMARKS. The example in the Collection, of which the measurements are here given, agrees well with the holotype, but has a slightly smaller umbilicus. There are also several transitions to the form described below as *K. evolutus*, Welter.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan (Meekoceras Beds). Timor.

SPECIMENS :

C. 33750. Toeboelopo, Timor. *M. E. Walsh Coll.*, 1930.

Kashmirites evolutus, Welter.

1922, p. 124, pl. clxiv, figs. 1-3 (holotype), 4, 5 (var. *bihatiensis*, Welter).

DIAGNOSIS. Like *K. subrobustus*, but with more delicate costation.

MEASUREMENTS :

Welter, p. 125	.	.	41	.	·29	.	·37	.	·44
C. 33752	.	.	56	.	·32	.	·36	.	·45

REMARKS. The Collection includes three typical examples which exceed Welter's holotype in size, while two more specimens, without the final, striate stage, may be intermediate between *K. evolutus* and such *Kashmirites* as those described by Welter as *K. cf. subarmatus*, Diener (pl. clxiv, fig. 6), and *K. subrobustus*. There is also a fragmentary example which probably represents the var. *bihatiensis* of the present species, with slightly different ribbing.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan (Meekoceras Beds). Timor.

SPECIMENS :

C. 33752-56. Toeboelopo, Timor. *M. E. Walsh Coll.*, 1930.

C. 33757. (var. *bihatiensis*). Toeboelopo, Timor.
M. E. Walsh Coll., 1930.

Kashmirites densistriatus, Welter.

1922, p. 123, pl. clxiv, figs. 9-11 (lectotype), 12-16.

DIAGNOSIS. Like *K. evolutus*, but with still closer and finer ribs, and a smaller umbilicus.

MEASUREMENTS :

Welter, p. 124 (lectotype) . 34 . 35 . 38 . 35

REMARKS. There is only an immature, entirely septate example of this species, of 28 mm. diameter ; but it agrees well with the inner whorls of the type. The curious alternation of striate and costate periods is reminiscent of the ornamentation of *Dumortieria* of the uppermost Lias (group of *Amm. radians*), and causes great individual variability.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan (Meekoceras Beds). Timor.

SPECIMENS :

C. 33751. Toeboelopo, Timor.

M. E. Walsh Coll., 1930.



FIG. 82.—a-d, *Hanielites elegans*, Welter. Two side- and two peripheral views, with suture-line of holotype. f, *Prohungarites tuberculatus* (Welter). Inner whorls (enlarged $\times 2$). All from Lower Trias of Timor. (After Welter, 1922, pl. clxviii, figs. 7-11, and pl. clxvii, fig. 16.)

? Genus **HANIELITES**, Welter.

1922, p. 145.

GENOTYPE. *Hanielites elegans*, Welter, 1922, p. 145, pl. clxviii, figs. 7-11.

DIAGNOSIS. More-or-less strongly ornamented and keeled offshoots of Kashmiritids, with coronate inner whorls and ceratitic suture-lines.

DISTRIBUTION. Upper Eo-trias, Owenitan. Timor.

REMARKS. The micromorphic type of this genus with its divergent whorl-sides might be taken to represent an extreme

form of the same stock that produced *Prohungarites tuberculatus*, Welter sp. (1922, p. 148, pl. clxvii, figs. 12-17), in which the early coronate and unkeeled stage (see fig. 82f) persisted to a much larger diameter, and in which the later ribs did not produce tubercles at the ventro-lateral edges. This, however, is clearly connected by the transitional *Prohungarites crasseplicatus*, Welter sp. (1922, p. 147, pl. clxviii, figs. 1-6), with the more typical *Prohungarites middlemissi*, Diener, and there is probably no real affinity between these two keeled groups. Moreover, *Hanielites* comes from the *Owenites* Beds, whereas the various forms of *Hungarites* described by Welter belong to a much later fauna.

J. Family MEEKOCERATIDÆ, Waagen emend.

1895, p. 236.

DIAGNOSIS. More or less involute, discoidal ammonites, smooth or feebly ornamented, with arched or tabulate venters often widening with increase in size, and simple ceratitic suture-lines, with broad saddles.

REMARKS. The comprehensive interpretation of this family recently adopted by Diener (1925, p. 81) comprises genera which are here referred to twelve different families, most of them already recognized by Waagen (1895) and Hyatt (1900). Waagen took as type of the genus *Meekoceras* White's *M. gracilitatis*, described below, and ranged with it *M. mushbachanum*, White; but *M. aplanatum* White, now *Wyomingites*, was referred by Waagen to his genus *Gyronites*. It will readily be seen, however, that *Meekoceras* [*Prionolobus*] *planulatum* (de Koninck), Waagen, referred to the *gracilitatis* group, differs as much from White's *M. gracilitatis* as Waagen's *M.* [*Xenodiscoides* ?] *falcatum* and *M.* [*Flemingites* ?] *fulguratum*, included in the *mushbachanum* group, differ from the true *M. mushbachanum*. Waagen cannot have examined actual specimens of the American species, and was misled by the unsatisfactory figures; but Diener, in 1925 (pl. xxiv, fig. 1), figured a true *Meekoceras* with its massive external saddles, yet considered it closely allied to the much earlier *Koninckites krafftii*, Spath (= "*Meekoceras varaha*", v. Krafft and Diener, 1909, *non* Diener, 1895a), with an entirely different suture-line.

The restricted genus *Meekoceras*, like the *Prionitids*, is probably an involute *Flemingitid* or *Gyronitid* development,

more or less parallel with *Wyomingites*. The simplified suture-lines of these two genera make it probable that they are not directly connected with *Prionolobus*, as here interpreted, although J. P. Smith (1932, p. 57) considered this a possible synonym of *Meekoceras*; and an independent origin in the primitive, persisting (originally Gyronitid) root-stock is more probable. Arthaber's *Meekoceras radiosum* (*non* Waagen, 1911, pl. xxi, figs. 14a-c) may be a true *Meekoceras*, as possibly is *M. caprilense*, Mojsisovics (1882, p. 214, pl. xxix, figs. 4, 5); but *Nicomedites*, Toulà, included in Meekoceratidæ by Hyatt (1900, p. 556) and J. P. Smith (1913, p. 645), is here referred with *Beyrichites*, Waagen, to a separate family, Beyrichitidæ, which is altogether more advanced than Meekoceratidæ.

Those genera of the Gyronitidæ, Paranoritidæ and Proptychitidæ, which were included by Hyatt (and later authors) in Meekoceratidæ, had been already separated from it by Waagen; and recent work has shown the desirability of not again uniting all the various groups in a single, comprehensive family Meekoceratidæ. Hyatt, moreover, while putting the genus *Gyronites* into his Meekoceratidæ, spoke of a family Gyronitidæ only in his definition of Flemingitids, in which he included *Wyomingites*. The agreement in suture-lines is close, and it is only because in the present Catalogue we have had to separate the Meekoceratidæ from the ancestral Flemingitidæ and Gyronitidæ, in order to deal first with certain offshoots of Paranoritidæ, that *Wyomingites* is so widely separated from the Gyronitids and Flemingitids.

Dieneroceras (p. 123) here included in Flemingitidæ, with which it is connected even by such features as the internal lobes, is a development of the same Gyronitid root-stock as *Wyomingites*; and the tendency to a square whorl-section suggests that even *Lecanites* (*Paralecanites*) *arnoldi*, Hyatt and Smith, should be referred to *Wyomingites*, in spite of its simple suture-line. To describe inner whorls of the group here discussed, and especially of Flemingitids, as "*Ophiceras*", "*Xenodiscus*", etc., *i. e.* genera of much earlier date, is to give an entirely wrong picture of the fauna which contains *Meekoceras*, and is characterized by the presence of such late types as Ussurids and *Anasibirites*.

The treatment of the Meekoceratids in J. P. Smith's latest work (1932) shows a curious lack of that appreciation of minute, but often essential, differences in ammonites which made Waagen's Salt Range memoir seem so much in advance of his

time, and which placed Hyatt so far above his disciple. The suture-lines of a typical *Arctoceras* and of *Meekoceras* have only to be compared in actual specimens to be recognized as widely distinct, still less identical, and *Meekoceras radiosum*, Waagen (see p. 105), with its slender external saddle, seems to me quite distinct from the form identified with it by J. P. Smith (1932, p. 59, pl. li, figs. 1-4). To include in *Koninckites* a form with umbilical tubercles (*Meekoceras* [*Koninckites*] *tuberculatum*, Smith, 1932, p. 62, pl. l, figs. 1-3), apparently a *Submeekoceras*, is to me as incomprehensible as to place the small *Meekoceras* figured in pl. xxxi, figs. 1-3 (as "*D.*" *bridgesi*, Smith), in the much later genus *Dagnoceras*; or to refer to *Ophiceras sakuntala*, Diener, a form with the suture-lines figured in pl. lvi, figs. 15 and 18.

Subdivision of the Meekoceratidæ may not seem necessary, but since Arthaber has already established a sub-family Arctoceratinæ, the three genera *Meekoceras*, *Wyomingites* and *Svalbardiceras* are now united in a restricted sub-family Meekoceratinæ.

1. Sub-family MEEKOCERATINÆ.

DIAGNOSIS. Meekoceratids with tabulate peripheries, except on the body-chambers of some adults.

REMARKS. The Meekoceratinæ probably contain other genera than the three listed above, especially among the later developments, but they are as yet too incompletely known for generic separation. Thus, as mentioned below, *Dagnoceras*, as interpreted by Arthaber, or even Smith, includes a mixture of different forms, some of which are probably Meekoceratinæ in the restricted sense; while the group of *Meekoceras sibiricum*, Mojsisovics (1886, p. 85, pl. xi, figs. 1a, b, 2-4), referred by Diener (1915a) to *Koninckites*, and by Frech (1905) to "*Aspidites*", probably also requires a new name.

Genus MEEKOCERAS, Hyatt, 1879.

In White, p. 11.

GENOTYPE. *M. gracilitatis*, White, 1880, p. 115, pl. xxxi, figs. 2a.

DIAGNOSIS. Discoidal, involute or evolute Meekoceratinæ, with tabulate venter and smooth or faintly striate sides. Suture-lines simple, ceratitic, with few denticulations in lobes.

DISTRIBUTION. Upper Eo-trias, Owenitan (= "Meekoceratan"). Idaho; California; Timor.

REMARKS. Hyatt and Smith (1905, p. 144) directed attention to the variability of *M. gracilitatis*, noticeable on the examination of a number of specimens; and they considered it nearly related to *M. boreale*, Diener (1895*a*, pl. i, figs. 3*a-c*), which,



FIG. 83.—*Meekoceras gracilitatis*, White. Upper Eo-trias, *Meekoceras* Beds. Idaho. (Adapted from Hyatt and Smith, 1905, pl. xiv, fig. 6, and pl. xiii, fig. 1 [*1a, b*, side- and sectional views of two examples], and pl. xii, figs. 6 and 10 [*c, d*, external suture-lines of two other specimens]. *d*, enlarged $\times 2$.)

however, when its complete suture-line is known, may be found to be more closely allied to the associated early *Paranoritids* (*Koninckites*). Hyatt and Smith also mention that there are in America, in addition to *M. gracilitatis*, a large number of undescribed forms; but their *M. pilatum* (p. 144, pl. lxiii, figs. 3–9) from the *Columbites* Beds of Idaho apparently is not

referable to the present genus, and may be a new form of *Arctoceratinæ*.

Since the above was written, J. P. Smith (1932) has figured a number of additional species of *Meekoceras*, of which *M. arthaberi*, *M. cristatum*, and *M. sylvanum* appear to belong to the *gracilitatis* group, probably also such species as *Clypeoceras pusillum*, *Dagnoceras bridgesi*, etc.; while most of the others are probably referable to *Submeekoceras* and the *Arctoceratinæ*.

Meekoceras gracilitatis, White.

Fig. 83, p. 247.

1880, p. 115, pl. xxxi, fig. 2a (b-d); Diener, 1915a, p. 191.

DIAGNOSIS. Platygyral, subleptogyral, angustumbilicate *Meekoceras*. Sides slightly convex, venter tabulate, umbilical wall high, but not steep. With faint striæ and occasional folds which, in the adult (with excentrumbilication), cross the venter in faint corrugations. Suture-line ceratitic (see fig. 86a, p. 253), with very simple dorsal elements.

MEASUREMENTS :

Hyatt and Smith (1905, pl. lxx,

figs. 4, 5)	.	.	.	.	77	·52	·25	·14
C. 21855	.	.	.	.	60	·51	·25	·13
C. 21856	.	.	.	.	52	·52	·26	·15
Dr. C. T. Trechmann Coll.	.	.	.	.	122	·44	·20(?)	·22

REMARKS. This form has been well described by Hyatt and Smith, who mentioned that the young shells were much more involute than mature forms, the umbilicus growing wider with age and the whorls less deeply embracing. This feature has been already noticed, though in a less pronounced degree, in *Koninckites* and other *Paranoritids* referred by v. Krafft and Diener to *Meekoceras*; but the suture-line is different in these, notably the internal portion. The peripheral aspect of true *Meekoceras* also is more like that of the *Prionitids*, and, indeed, a new Spitsbergen form of "*Goniodiscus*" was previously (Spath, 1921, p. 300) considered to be closely comparable to the present species.

HORIZON AND LOCALITIES. Upper Eo-trias, *Meekoceras* Beds. Idaho and California.

SPECIMENS :

C. 21855-7. Aspen Mountains, near Bear Lake, S.E. Idaho.
(ex J. Perrin Smith Coll.). Presented

Dr. C. T. Trechmann, 1920.

Genus **WYOMINGITES**, Hyatt.

1900, p. 556 ; Diener, 1915a, p. 310.

GENOTYPE. *Meekoceras aplanatum*, White, 1880, p. 112, pl. xxxi, figs. 1a-d.

DIAGNOSIS. Evolute, flattened Meekoceratinae, with tabulate venter, tending to widen and become subsulcate. Sides smooth

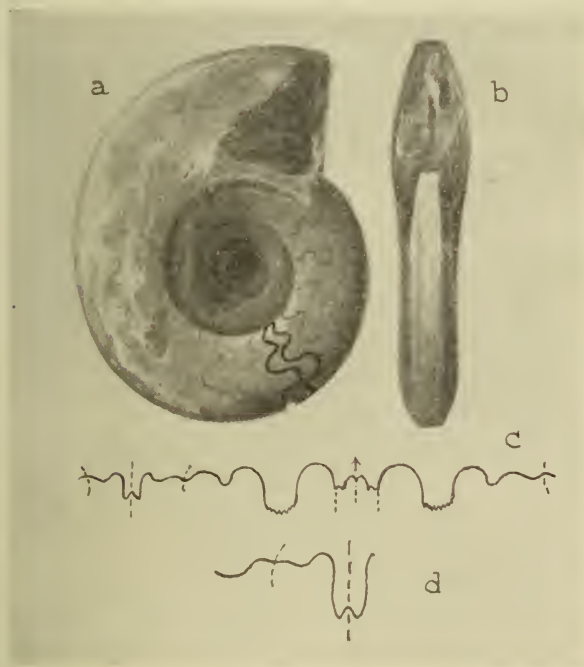


FIG. 84.—*Wyomingites aplanatus* (White). Upper Eo-trias, *Meekoceras* Beds. Idaho. a-c, Adapted from Hyatt and Smith, 1905, pl. lxiv, figs. 17, 18 (side- and peripheral views, enlarged $\times 1\frac{1}{2}$) and pl. xi, fig. 10 (complete suture-line, enlarged $\times 3$, of another example). d, Internal lobe of a specimen (B.M., C. 21853) at diameter of 25 mm., enlarged \times about 5.

or with radial folds. Suture-line with only two lateral lobes and saddles, goniatic in the more simple (reduced ?) forms.

DISTRIBUTION. Upper Eo-trias, *Meekoceras* Beds. Idaho.

REMARKS. The genotype is undoubtedly *Meekoceras aplanatum*, and neither Smith nor Hyatt were entitled to substitute a different species (*W. whiteanus*) at a later date (1905, p. 147).

J. P. Smith consequently dropped the name *Wyomingites*, although it is needed, and included the American forms first in *Danubites*, Mojsisovics, then in *Xenodiscus* [*W. whiteanus*], *Gyronites* and *Flemingites*, Waagen [*G. aplanatum*], respectively; but the genera *Wyomingites*, *Flemingites* and *Gyronites* are only homœomorphs at certain stages, agreeing merely in loose coiling and a correspondingly small number of sutural elements, but differing considerably in the adult. In larger whorls of *Wyomingites* there is a tendency to widen the periphery, which may become even sub-concave. This indicates a more specialized stock, sufficiently different from the earlier *Gyronites* and *Prionolobus* assemblage, as well as from *Flemingites*, for generic separation. The reference to *Danubites* or *Xenodiscus* of the evolute *W. whiteanus* must be considered to be as erroneous as the inclusion of the simple (reduced?) *W. arnoldi* in the Permian genus *Paralecanites*, Diener, by Hyatt and Smith, or in *Paraceltites* by Frech. The latter author (1908, pl. lxi) refigured White's "*Meekoceras*" *aplanatum* and referred it to the genus *Ophiceras*; but this also is quite inadmissible, as is Arthaber's (1911, p. 228) inclusion of the two American species in the genus *Xenodiscus*. Diener, after Hyatt and Smith, again included *Wyomingites* in the synonymy of *Meekoceras* (sub-genus *Gyronites*), but referred *W. whiteanus* itself to *Xenodiscus*.

***Wyomingites aplanatus* (White).**

Fig. 84, p. 249.

1880, p. 112, pl. xxxi, figs. 1a, b, d only.

DIAGNOSIS. Subplatygyral, subleptogyral, sublatumbilicate *Wyomingites*. Sides almost flat, venter tabulate, tending to subsulcate; smooth or with indistinct folds, especially on body-chamber. Suture-line ceratitic, with short internal saddle and comparatively wide internal lobe (see fig. 84d).

MEASUREMENTS :

White's type figure	. 61	. .38	. .21	. .38
Hyatt and Smith, 1905,				
p. 147	. .	. .	. .	. .37
C. 21852	. .	. 70	. .38	. .23 . .37
C. 21853	. .	. 55	. .37	. .19 ? . .40

REMARKS. The two specimens from which the above measurements were obtained are slightly deformed and elliptical; in the first the dimensions are those of the shorter diameter, in the second of the longer. The larger specimen, moreover,

seems to be slightly more inflated than the type, but is still considerably more compressed than *W.* ["*Paralecanites*"] *arnoldi*, Hyatt and Smith sp., which also has a simpler suture-line. The smaller example shows folds on the outer whorl, even more distinct on the first septate half than on the final body-chamber, just as in the more evolute *W. whiteanus* (Waagen).

Stolley (1911, p. 123, pl. ix, fig. 5) recorded "*Gyronites aplanatus*" from the *Arctoceras* Beds of Spitsbergen, and the writer (1921, p. 303) doubtfully attached comparable specimens from the *Posidonomya* Shales to the same species (B.M., C. 27204, 27151-2). They have nothing to do with the true *Gyronites*, and are probably referable to *Svalbardiceras*.

HORIZON AND LOCALITIES. Upper Eo-trias, *Meekoceras* Beds. Idaho and California.

SPECIMENS :

C. 21852-3. Aspen Mts., near Bear Lake, S.E. Idaho, U.S.A.

(ex *J. Perrin Smith Coll.*). Presented

Dr. C. T. Trechmann, 1920.

Genus SVALBARDICERAS, Frebold.

1930, p. 23.

GENOTYPE. *Svalbardiceras spitzbergense*, Frebold, 1930, p. 24, pl. vi, figs. 1, 1a (lectotype), 2, 3 ; 1929a, p. 299, pl. i, fig. 1 (?*Lecanites*).

DIAGNOSIS. Flat, discoidal Meekoceratinæ with tabulate venter, tending to round off in the adult ; with gradumbilicus ; and with only faint ribbing, showing chiefly as distant bulges on the innermost whorls. Suture-line simple, with two lateral lobes, goniatitic (or ceratitic ?).

DISTRIBUTION. Upper Eo-trias. Spitsbergen ; Siberia.

REMARKS. Frebold took *Svalbardiceras* to be common to his *Grippia*-horizon and to his Lower Saurian Bed, which he placed in the Middle Trias ; but his "*Beyrichites*" *affinis* seems to me to be an *Arctoceras*. *Svalbardiceras* thus is probably of Eo-triassic age, and I take it to include those *Gyronites* ? to which I referred in 1921 (p. 303). It may also include the group of "*Xenodiscus*" *schmidti*, Mojsisovics (1886, p. 77, pl. xi, figs. 8a, b [lectotype]), and *Gyronites mojsisovicsi*, Waagen (*ibid.*, figs. 11a, b), referred to on p. 90 under *Gyronites*, but in the absence of original material from Olenek, I am unfortunately dependent on Mojsisovics's figures.

Such forms as "*Dagnoceras*" *pealei* and "*D.*" *haydeni*, Smith (1932, p. 66, pl. xxix, figs. 24-37 and 1-8), morphologically

intermediate between *Meekoceras* and *Svalbardiceras*, seem to me closer to the present stock than to the true *Dagnoceras*.

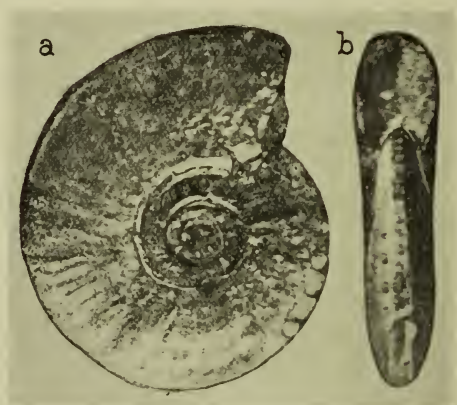


FIG. 85.—*Svalbardiceras spitzbergense*, Frebold. Upper Eo-trias, "Grippia-horizon". Spitsbergen. (After Frebold, 1930, pl. vi, figs. 1, 1a.)

2. Sub-family ARCTOCERATINÆ, Arthaber, emend.

1911, p. 178 (as sub-family of Meekoceratidæ).

DIAGNOSIS. More-or-less involute discoidal Meekoceratidæ with arched venters, slightly sigmoidal striæ, folds on outer whorls, and simple ceratitic suture-lines.

REMARKS. Hyatt and Smith (1905, p. 149) separated White's *Meekoceras mushbachanum* from the typical *gracilitatis* group, and referred it to the sub-genus *Koninckites*, on account of its greater evolution and more rugose shell, mentioning at the same time that there were several species in the American Triassic, both in Idaho and California, that would fall into this division. *M. mushbachanum*, however, was the only one described in 1905 (p. 148). Those who have compared typical Salt Range *Koninckites* with examples of White's form will have noticed that the ornamentation and whorl-shape are of an entirely different type, even if there is superficial agreement in the external suture-line. When describing *Flemingites*? *russelli*, Hyatt and Smith, it was mentioned (p. 112) that this form was not so close to the true *Flemingites* as appeared at first sight. The more involute and smooth inner whorls, the prorsiradiate striation of their peripheral areas, and the simpler suture-line,

make it probable that this group is transitional from the typical Flemingitids to *Submeekoceras*, just as *Flemingites bannockensis*, Smith (1932, p. 52, pl. xxiii, figs. 18-20), is transitional to *Wyomingites*.

In 1932 Smith described (as *Koninckites*) some more forms of the *mushbachanum* group, but it is as yet doubtful whether

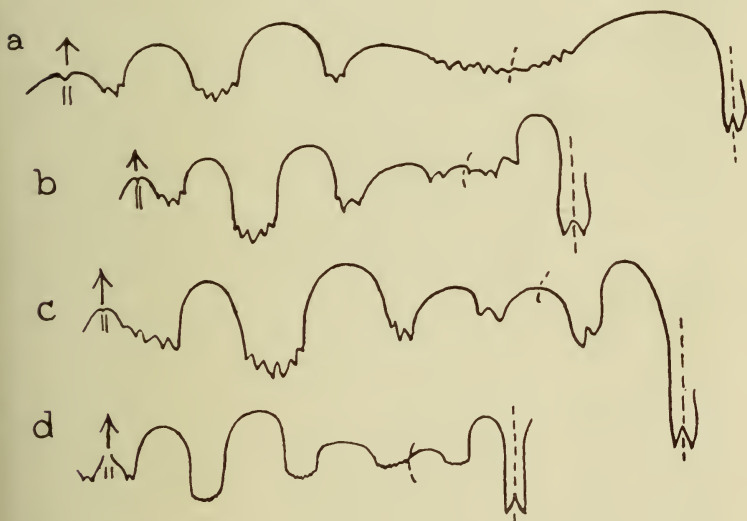


FIG. 86.—Complete suture-lines of *a*, *Meekoceras gracilitatis*, White. Dr. C. T. Trechmann Coll., at diameter = 60 mm. (enlarged \times about $1\frac{1}{2}$). *b*, *Submeekoceras mushbachanum* (White). Same collection, at diameter = about 50 mm. (enlarged \times 2; composite). *c*, *Flemingites?* *russelli*, Hyatt and Smith. B.M., C. 21854b, at diameter = 70 mm. (enlarged \times about $1\frac{1}{2}$). All from the Upper Eo-trias, *Meekoceras* Beds, Idaho. *d*, Complete suture-line of a true Lower Eo-triassic Ophiceratid, for comparison (*Ophiceras* [*Lyttophicerus*] *commune*, Spath, from near Cape Stosch, Greenland, see Spath, 1930, pl. ii, figs. 13, 14). Note the minute tothing of the lobes, including the dorsal lobes, and the narrowness of the first lateral lobe.

late types like *M. curticostatum*, Smith (1932, p. 56, pl. xlviii, figs. 21-30), should also be referred to *Submeekoceras*. *Submeekoceras malayicum* (Welter) is another species; *Prionolobus* (later *Ophiceras* and *Xenodiscus*) *waageni*, Hyatt and Smith (1905, p. 150, pl. lxxvii, figs. 3-8), may be a reduced form of the present family; and there are others connecting *Submeekoceras* with *Dagnoceras*, discussed below.

Arctoceras is probably closely allied to *Submeekoceras*, but it is not identical with it or with *Meekoceras* s.s., as Smith held (1932, p. 31). It seems unnecessary to separate the more ornamented species from the typical smooth forms, since there are so many transitions between them. *Arctoceras* differs from the similar *Submeekoceras* chiefly in the proportions of the elements of the suture-line, external and internal; but forms like the Siberian *Xenodiscus euomphalus* (Keyserling), Mojsisovics (1886, pl. xi, figs. 7a, b), connect the two stocks.

Arctoceras also bears some distant resemblance to the much earlier *Koninckites*, but also has different saddles, especially a large external saddle, and other peculiarities. Some of the forms included by Mojsisovics in his group of *Meekoceras sibiricum*, e. g. "*M.*" *rotundatum* (Mojsisovics, 1886, pl. x, figs. 16a, b), with inflated body-chamber, or the excentrumbilicate "*M.*" *keyserlingi* (Mojsisovics, *ibid.*, figs. 13-15), indicate the existence of yet another, different and un-named Arctoceratid stock. One of the examples of the last species (Mojsisovics's fig. 13) shows so much resemblance to the form here figured (Pl. V, fig. 1, and fig. 46, p. 159) as *Clypeoceras* (*Koninckites*?) *largisellatum* (Koken MS.), sp. nov., that only its association with the other forms of the Olenek fauna suggests that it probably represents merely a homœomorph, to be distinguished possibly only by its internal lobes. This doubtful group of "*Meekoceras*" cannot yet be attached either to *Arctoceras* or to an earlier genus. *Czekanowskites*, Diener, is an inflated development of the Arctoceratinæ, transitional to Stephanitidæ, but *Pseudokymatites* and *Stacheites* are only provisionally included in this sub-family.

Arthaber (1911, p. 178) included his *Dagnoceras* in the sub-family Arctoceratinæ. This association is not here adopted. The Albanian fauna is so unsatisfactorily preserved, and Arthaber included in this genus such a heterogeneous assemblage of forms that, until better material is available and the different forms are more accurately known, its inclusion in a separate sub-family must be considered to be provisional. The Dagnoceratinæ may be reduced offshoots of the root-stock that persisted with such forms as "*Ophiceras*" (first "*Prionolobus*" *jacksoni*, Hyatt and Smith (in Smith, 1932, p. 49, pl. lxii, figs. 11-21), and "*Ophiceras*" *spencei*, Hyatt and Smith (1905, p. 119, pl. lxii, figs. 1-4 only), which could possibly also be included in *Submeekoceras*, and certainly have nothing to do with the true *Ophiceras*.

Genus **SUBMEEKOCERAS**, nov.

GENOTYPE. *Meekoceras mushbachanum*, White (1880), in Hyatt and Smith, 1905, pl. xvi, figs. 1-3, only (lectotype).

DIAGNOSIS. More-or-less evolute, robust *Arctoceratinae*, bearing striae, sometimes bundled into blunt folds, and having ceratitic suture-lines with slenderer saddles than in *Arctoceras*.

DISTRIBUTION. Upper Eo-trias, Owenitan (= Meekoceratan). Idaho; California, U.S.A.; Timor?.

REMARKS. It is uncertain whether the form from Timor recorded by Welter (1922, p. 126) is really identical with White's species; and on p. 87 this author quotes it as *Meekoceras* cf. *mushbachanum*. The comparable *M. malayicum*, Welter (1922, p. 127, pl. clxv, figs. 6-9), said to have a more tabulate ventral area, agrees in ornamentation, but in its suture-line shows transition to *Dagnoceratinae*.

Submeekoceras mushbachanum (White).

Fig. 87, p. 256.

1880, p. 114, pl. xxxii, figs. 1a-d; Diener, 1915a, p. 193 (*Meekoceras*).

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Submeekoceras*. Venter narrowly arched, flattened sides, with striae of growth and faint, low folds. Suture-line (see fig. 86b, p. 253) ceratitic, with coarse denticulations of the lobes.

MEASUREMENTS:

Hyatt and Smith, pl. xvi	.	100	.	.48	.	?	.	.22
C. 21859	.	.	.	64	.	.47	.	.25 .21
C. 21858	.	.	.	115	.	.43	.	.25 .30

REMARKS. The examples of this species in the Collection and in the possession of Dr. C. T. Trechmann were determined by Prof. J. Perrin Smith; but, like his illustrations, they include a variable series of forms, some of which may even belong to other genera, e.g. the original of his pl. xviii, figs. 3-5. The largest example before me (C. 21858) is slightly deformed elliptically, but is distinctly more coarsely ribbed than the specimen selected to illustrate the genotype (Hyatt and Smith, pl. xvi); it is also more evolute, but it may yet be identical with White's type. The specimen from which the complete suture-line (fig. 86b, p. 253) was drawn is similarly evolute, and shows the compressed inner whorls, as in White's sectional view (pl. xxxi, fig. 1c), but the other specimens are more involute. The

largest example shows also a deeper external lobe and a very large external saddle, together with ascending auxiliaries, as in the costate forms of *Arctoceras*.



FIG. 87.—*Submeekoceras mushbachanum* (White). [Side- and sectional views of two examples from the Upper Eo-trias of Idaho. (After Hyatt and Smith, 1905, pl. xvi, fig. 1, and pl. xv, fig. 3, the latter a reproduction of White's holotype, 1880, pl. xxxii, fig. 1c.)

HORIZON AND LOCALITIES. Upper Eo-trias. Idaho ; California.

SPECIMENS :

C. 21858-60. Aspen Mts., Idaho (ex *J. Perrin Smith Coll.*).

Presented Dr. C. T. Trechmann, 1920.

Genus **ARCTOCERAS**, Hyatt.¹

1900, p. 559; Diener, 1915a, p. 52; Strand, 1929, p. 6 (" *Arctocero-*
cerodes "); Spath, 1929, p. 269.

GENOTYPE. *Ceratites polaris*, Mojsisovics, 1886, p. 31, pl. vii, figs.
1a, b.

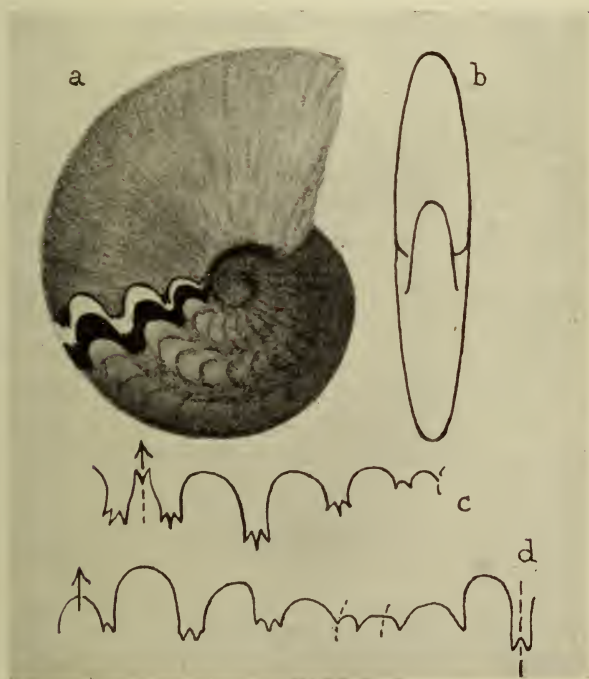


FIG. 88.—a, b, *Arctoceras polare* (Mojsisovics). Upper Eo-trias (*Posidonomya* limestone). Spitsbergen. (After Mojsisovics, 1886, pl. vii, figs. 1a, b.) c, *Arctoceras lindstroemi* (Mojsisovics). External suture-line. Same formation and locality. (After Mojsisovics, 1886, pl. viii, fig. 2b.) d, *Arctoceras whitei* (Mojsisovics). Complete suture-line. Same formation. Trident, Sassendal, Spitsbergen. (B.M., C. 21729, enlarged $\times 1\frac{1}{2}$.)

DIAGNOSIS. More-or-less involute, discoidal Arctoceratinæ with narrowly arched venter, smooth or striate; flattened sides and ceratitic suture-lines with wide and low saddles.

RANGE. Upper Eo-trias, Columbitan? Spitsbergen.

¹ *Arctoceras*, J. Boehm, 1899, p. 325 (now *Nathorstites*) has no standing, but *Arctoceras*, Hyatt, has yet to be standardized.

REMARKS. The writer has previously used the generic name *Arctoceras*, Hyatt (1921, p. 298), stating that Prof. J. Böhm's genus *Arctoceras*, 1899 (p. 326), was withdrawn in 1903 (p. 61) in favour of Hyatt's name, and that a new genus—*Nathorstites*—was then proposed by Böhm for his Carnian group. Böhm's genus of 1899 having been withdrawn, Diener (1915a, p. 52) and other authors have accepted Hyatt's *Arctoceras*, and it is here again used for the group of *Ceratites polaris*. The association of forms of this genus with ammonites ascribed to "*Keyserlingites*", "*Prionites*", and types found in the Upper Ceratite Limestone of the Salt Range, indicates, on the one hand, that *Arctoceras* is not of Anisian age, as claimed by Diener, and, on the other, that it is probably later than the *Columbites* Beds of Idaho, where *Tirolites*, "*Celtites*" and "*Pseudharpoceras*" fore-shadow the later forms of the next higher age.

The apparent restriction of *Arctoceras* to Spitsbergen may be explained by the fact that deposits of Prohunganitan age are so far known only from few localities, and those of dates slightly different from that of the Spitsbergen Beds.

Arctoceras polare (Mojsisovics).

Fig. 88a, b, p. 257.

1886, p. 31, pl. vii, figs. 1a, b (type), 2 (*Ceratites*); Diener, 1915a, p. 52; Spath, 1921, p. 299.

DIAGNOSIS. Platygyral, subleptogyral, angustumbilicate *Arctoceras*. Whorl-section compressed, elliptical, sides almost flat, venter arched. Fine, slightly sigmoidal, striæ of growth, and steep umbilical wall with rounded edge. Suture-line ceratitic, with unusually shallow and wide lobes and saddles.

MEASUREMENTS :

Mojsisovics, p. 32	.	.	53	.	·51	.	·21	.	·13
C. 21730	.	.	42	.	·52	.	·22	.	·15

REMARKS. As Mojsisovics stated, this species is distinguished from *A. blomstrandii*, discussed below, merely by slight differences in the suture-line. Since a number of the Spitsbergen examples are preserved in coarsely crystalline calcite, it is not always possible to refer each of these smooth, discoidal forms to its correct species. *A. whitei* is slightly more inflated and has a wider umbilicus.

One of the examples (C. 27037) shows incipient strigation, as in *Arctoceras lindstroemi* described below; another specimen

(C. 27038), complete at 65 mm. diameter, has slight bundling of the striæ on the body-chamber, as in *A. oebergi*.

It is possible that the specimen previously recorded (Spath, 1921, p. 299) as *A. simplex* is merely an immature example of the present species. It shows neither the suture-line nor a notched umbilical rim, and it is slightly more compressed than similar, immature, *A. blomstrandii*. *A. polare* as well as *A. simplex* and related forms are, however, represented in the material collected by Mr. R. W. Segnit in 1921.

HORIZON AND LOCALITIES. Upper Eo-trias, *Posidonomya* Beds. Spitsbergen.

SPECIMENS :

C. 21730, 27037-9, 27065, 28647, 27066-7 (?) , 27033 (?). Trident, Sassendal. *Dr. J. W. Gregory Coll., 1896.*

C. 25246. Near Cape Wijk.

Collected and presented by G. W. Lamplugh, 1924.

C. 37221-2, 37224-8. Sassendal, Ice Fjord.

R. W. Segnit Coll., 1921.

A number of minute examples (C. 27054-7, 27059, 27069-73), previously recorded from Spitsbergen (Spath, 1921, p. 299), cannot be satisfactorily determined. Similarly we may doubtfully include here some impressions from the Trident and Sticky Keep in Sassendal (C. 27022-4, 27027, 27030-31), although these might even belong to Anisian Hungaritids, etc.

Arctoceras blomstrandii (Lindström).

1865, p. 4, pl. i, fig. 3 ; Mojsisovics, 1886, p. 29, pl. vi, fig. 8 (*Ceratites*), Spath, 1921, p. 299 ; Frebold, 1930, p. 19.

DIAGNOSIS. Like *A. polare*, but with narrow and deep, trifid, lateral lobes.

MEASUREMENTS :

Mojsisovics :	I (about)	75	.	·52	.	·24	.	·13
„	II	59	.	·51	.	·24	.	·11
C. 27150	.	50	.	·53	.	·28	.	·13

REMARKS. This species is connected by transitions with *A. polare*, and it is often difficult to decide whether the lateral lobes are narrow enough for inclusion of the transitional examples in the one species rather than in the other. In its slightly greater whorl-thickness *A. blomstrandii* is also transitional to *A. whitei*, which, however, has a wider umbilicus. *A. simplex* is characterized by its different suture-line and crenulate umbilical rim. As Wepfer ('Palæontographica', lix, 1912,

p. 7) pointed out, the differences among the forms of this group are very subtle.

HORIZON AND LOCALITIES. Upper Eo-trias, *Posidonomya* Beds. Spitsbergen.

SPECIMENS :

C. 27034, 27068. Trident, Sassendal.

Dr. J. W. Gregory Coll., 1896.

C. 27150. West Trident, Sassendal.

Collected and presented by Prof. E. J. Garwood, 1896.

Some impressions from the same locality and collection (C. 27018-21) may be provisionally included here.

C. 37220 ?. Sassendal.

R. W. Segnit Coll., 1921.



FIG. 89.—*Arctoceras whitei* (Mojsisovics). Side- and peripheral views of paratype and lectotype from the Upper Eo-triassic (*Posidonomya* Limestone) of Spitsbergen. (After Mojsisovics, 1886, pl. vi, figs. 5*a*, *b*, 6*a*, *b*.) (For suture-line see fig. 88*d*, p. 257.)

Arctoceras whitei (Mojsisovics).

Fig. 89.

1886, p. 32, pl. vi, figs. 6*a*, *b* (lectotype), 5*a*, *b*; Spath, 1921, p. 297; Frebold, 1930, p. 18, pl. v, figs. 1-3.

DIAGNOSIS. Like *A. blomstrandii*, but more inflated and with umbilicus slightly larger. Suture-line ceratitic with rather short external lobes (see fig. 88*d*, p. 257).

MEASUREMENTS :

Mojsisovics, p. 33	.	51	.	·46	.	·30	.	·20
C. 27040	.	50	.	·48	.	·30	.	·91

REMARKS. This species is much more abundantly represented than the two previously described, but of the immature forms included here, some may possibly be the young of *A. oebergi* or similar species. They differ from the inner whorls of *A. polare* and *A. blomstrandii* merely in greater whorl-thickness. At 13 mm. diameter the umbilicus is 30% of the diameter. Even if it is impossible to distinguish them specifically, the compressed young of *Arctoceras* can generally be separated from the more involute or more rounded-whorled immature examples of other ammonites that occur with them. Mojsisovics characterized the species as being intermediate in general appearance between *A. blomstrandii* and *A. oebergi*, discussed below.

HORIZON AND LOCALITIES. Upper Eo-trias, *Posidonomya* Beds. Spitsbergen.

SPECIMENS :

C. 27084-5. Lower line of nodules in Flags, 400-450 ft. above Camp, Sassendal, Spitzbergen.

Collected and presented by Prof. E. J. Garwood, 1896.

C. 27040-52. Lowest Limestone, West Trident, Sassendal.

Same collection.

C. 21729, 27060-4, 27078, 27079-83. Trident, Sassendal.

J. W. Gregory Coll., 1896.

A number of impressions from the same locality and from Sticky Keep ("Upper Flags") in the Gregory and Garwood Collections (C. 27025-6, 27028-9, 27032, 27274) are too indefinite to be identified specifically or even generically.

C. 37223. Sassendal.

R. W. Segnit Coll., 1921.

***Arctoceras oebergi* (Mojsisovics).**

1886, p. 33, pl. vii, figs. 6a, b (lectotype), 5; pl. viii, figs. 1, 3 (*Ceratitis*); Spath, 1921, p. 299; Frebold, 1930, p. 19.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Arctoceras*. Sides flat, venter arched, sigmoidal striæ of growth, developing into irregular ribs on outer whorls, thickened towards periphery (but not passing over it), and nodate on edge of a high and steep umbilical wall. With a tendency to strigation. Suture-line ceratitic, with four teeth in first lateral lobe and two in the second.

MEASUREMENTS :

Mojsisovics	I (p. 34)	. 72	. .44	. .26	. .21
"	II "	. 105	. .50	. .26	. .24
C. 21723		. 77	. .44	. .25	. .22
Dr. G. W. Tyrrell Coll.					
(Aa29)		. 80	. .49	. .26	. .18

REMARKS. *A. oebergi* is distinguished from the very similar *A. lindstroemi* (Mojsisovics) merely by its lobes. It is possible that both are only varieties of *A. costatum* (Oeberg), the present species being transitional to *A. whitei*, and *A. lindstroemi* intermediate between this and the slightly coarser type. The numbers of denticulations in the lobes may vary on opposite sides of the same individual (*e.g.* C. 21723), and is thus obviously an unsatisfactory criterion. The presence of umbilical nodes also depends apparently on size only, since they tend to appear sooner or later in all the costate forms of *Arctoceras*.

Mojsisovics recognized involute and evolute varieties. In the unique holotype of *A. costatum* the umbilicus was stated to measure 28% of the diameter, and in *A. lindstroemi* only 24%. Since examples of the last species with diameters measuring as much as 120 and 150 mm. have the umbilical tubercles and suture-line of *A. oebergi*, and the open umbilicus of *A. costatum*, it is clear that the width of the umbilicus is as insufficient for specific distinction of these three supposed species as the other characters mentioned.

HORIZON AND LOCALITIES. Upper Eo-trias, *Posidonomya* Beds. Spitsbergen.

SPECIMENS :

C. 21723. West Spur of Trident, Sassendal ("Lowest Limestone"). *Prof. E. J. Garwood Coll., 1896.*

C. 27036, 27077. Trident.

Prof. J. W. Gregory Coll., 1896.

The example in Dr. Tyrrell's Collection above listed is "from a nodule in shale series, Knoll at 890 ft. up on east face of valley opposite Mt. Holmgard, Angerdsdal, Spitsbergen".

Arctoceras costatum (Oeberg).

1877, p. 13, pl. iv, fig. 3, lectotype (*Ceratites*), *non* fig. 4; Mojsisovics, 1886, p. 36, pl. vii, figs. 3a, b (refiguration of lectotype); Spath, 1921, p. 299.

DIAGNOSIS. Like last species (*A. oebergi*), but more inflated

and less smooth on the inner whorls; umbilical tubercles not developed until a later stage.

MEASUREMENTS :

Mojsisovics, p. 37	.	.	78	.	·38	.	·23	.	·28
C. 27035	.	.	20	.	·50	.	·38	.	·28

REMARKS. The comparatively strong ribbing of the only small example available (C. 27035), and its greater inflation almost resembling the (unrelated and still more globose) "*Ceratites*" *decipiens*, Mojsisovics (1886, p. 27, pl. vi, fig. 9a), indicate that it does not represent the inner whorls of the form last described. At a diameter of only 20 mm. there are already over three-quarters of a whorl of body-chamber, but indications of two incompletely formed septal edges at the base of this. The suture-line resembles that of other immature *Arctoceras*. The umbilical terminations of the ribs are, perhaps, more distinctly thickened than in Mojsisovics's illustration of the holotype. It may be mentioned that the writer does not consider, as that author does, that the large fragment figured by Oeberg (pl. iv, fig. 4) cannot possibly belong to *A. costatum*. The curvature of the ribs is probably wrongly drawn; but umbilical tubercles would be expected at that diameter. On account of their defective preservation the three impressions of large forms of this type (C. 27074-6) are only doubtfully included here. A similar umbilical cast, listed above under *A. oebergi* (C. 27077), merely shows the umbilical crenulation at a smaller diameter.

HORIZON AND LOCALITIES. Upper Eo-trias, *Posidonomya* Beds. Spitsbergen.

SPECIMENS :

C. 27035. Nodule Beds, Trident, Sassendal.

J. W. Gregory Coll., 1896.

C. 27074-6 ?. Trident.

Same Coll.

Arctoceras lindstroemi (Mojsisovics).

1886, p. 35, pl. viii, figs. 2a, b (holotype); Spath, 1921, pp. 299, 302.

DIAGNOSIS. Intermediate between the two previous species (*A. oebergi* and *A. costatum*); suture-line (see fig. 88c, p. 257) with trifid lobes.

MEASUREMENTS :

Mojsisovics, p. 35	.	.	115	.	·44	.	·23	.	·24
C. 27036	.	.	120	.	·44	.	·26	.	·28
C. 21959	.	.	85	.	·45	.	·24?	.	·24

REMARKS. It has already been mentioned that the separation of this form from the two species previously described is impossible on the basis of the suture-line, the width of the umbilicus or the presence of umbilical tubercles. Wepfer (1911, p. 7) was correct in stating that all the forms of the group of Oeberg's "*Ceratites blomstrandii*" were very closely allied, and that there was the greatest difficulty in attempting the determination of the transitional examples, which are far commoner than the types. The three examples which are here referred to the present "species" are clearly different from *A. oebergi*, which has inner whorls like those of *A. whitei*, and from *A. costatum*, which has a far less tabulate periphery. Yet the reference to *A. lindstroemi* may equally be questioned, for not only is the strigated periphery comparable to that of the large example included by Mojsisovics (pl. viii, fig. 3b) in *A. oebergi*, but the suture-line of the largest example is also that of this species or of *A. costatum*. The ribs, however, are thickened towards the periphery, and already pronounced at small diameters; whilst the suggestion of greater whorl-thickness, not borne out by the measurements, is due to the wide ventral area.

HORIZON AND LOCALITIES. Upper Eo-trias, *Posidonomya* Beds. Spitsbergen.

SPECIMENS :

C. 21959, 36344. Trident, Sassendal.

Prof. J. W. Gregory Coll., 1896.

C. 27053. Lowest Limestone, 450 ft. above camp, Mt. Marmier.

Prof. E. J. Garwood Coll., 1896.

(This example was referred to as containing *Prospiringites* ? spp. in its body-chamber.)

Genus **CZEKANOWSKITES**, Diener.

1915a, p. 115; Frebold, 1930, p. 20.

GENOTYPE. *Ceratites decipiens*, Mojsisovics, 1886, p. 27, pl. vi, fig. 9.

DIAGNOSIS. Arctoceratids with rather globose inner whorls. Costation as in ribbed *Arctoceras*, but suture-lines with higher saddles and more numerous digitations of the lobes.

DISTRIBUTION. Upper Eo-trias, Columbitan ?. Siberia; Spitsbergen ?.

REMARKS. Diener lists only three forms of this genus, which is not represented in the Collection, unless it includes some of the indeterminable, immature, Spitsbergen examples (Nos.

C. 27058, 27200-03) previously recorded by the writer (1921, p. 299) as resembling the young of *Czekanowskites decipiens* and of *Olenikites sigmatoideus* (Mojsisovics). These are associated with numerous young *Arctoceras*, and, apparently, are connected with them by transitional forms.

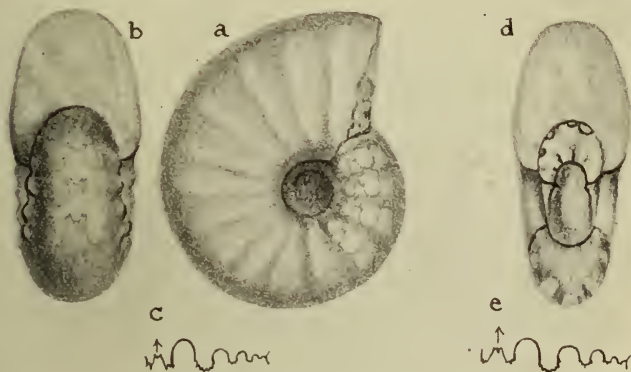


FIG. 90.—a-c, *Czekanowskites decipiens* (Mojsisovics). Upper Eo-trias. Mouth of Olenek River, Siberia. Side- and peripheral views and suture-line of holotype. d, e, *Czekanowskites inostranzeffi* (Mojsisovics). Same formation and locality. Sectional view and suture-line. (After Mojsisovics, 1886, pl. vi, figs. 9a-c, 10b, c.)

? Genus **PSEUDOKYMATITES**, nov.

Supra, p. 105.

GENOTYPE. *Kymatites svilajanus*, Kittl, 1903, p. 69, pl. iv, fig. 3.

DIAGNOSIS. Discoidal, smooth Meekoceratids(?) with two entire lateral lobes.

DISTRIBUTION. Upper Eo-trias, Columbitan. Dalmatia.

REMARKS. Kittl thought that, apart from the suture-line, the genotype of this genus could be attached to *Dinarites*, and his reference of it to Waagen's *Kymatites* was provisional. It is more probable, however, that there is no real affinity with the earlier Kymatitinae which are developments of the Gyronitids, more-or-less parallel to Paranoritids, but without their tendency to frilling of the elements of the suture-line.

The presence of a second lateral lobe again might be expected

to occur in a discoidal form like *P. svilajanus*, as compared with the single broad lateral saddle of, e. g., "*Dinarites*" *tirolitoides*, Kittl (1903, pl. vii, fig. 2), because the tendency to increase the elements of the suture-line with the flattening of the lateral area is seen in homœomorphous derivatives of many stocks. Considering that the lobes are entire, however, it is more probable that the *Pseudokymatites* suture-line is degenerate,

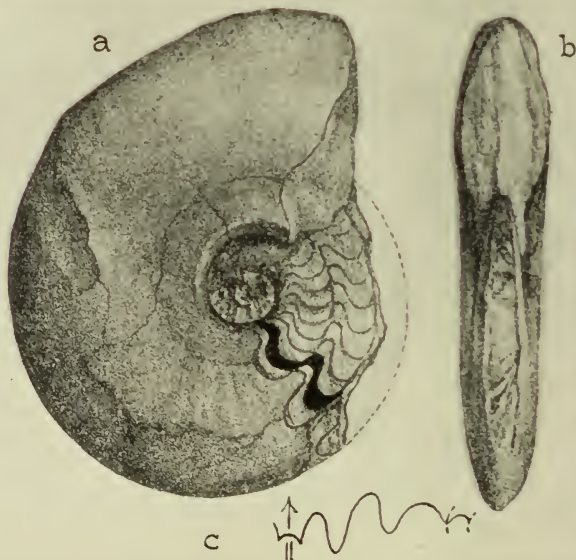


FIG. 91.—*Pseudokymatites svilajanus* (Kittl). Side- and peripheral views and suture-line of holotype from the Upper Eo-trias of Muć, Dalmatia. (After Kittl, 1903, pl. iv, fig. 3.)

though less so than the *Dinarites* suture-line. And since the Meekoceratidæ were a prolific stock, existing before, as well as after the time-range of *Pseudokymatites*, it is probable that this genus, as well as *Stacheites*, discussed below, represent offshoots of the important family Meekoceratidæ, in spite of their apparent isolation in the *Tirolites* Sea.

The resemblance of the suture-line to that of "*Lecanites*" *undatus*, Waagen (1895, p. 281, pl. xxxviii, figs. 1a-c) is accidental, for the holotype of this species (apart from being perhaps worn) is clearly a Gyronitid of much earlier date.

? Genus **STACHEITES**, Kittl.

1903, p. 27.

GENOTYPE. *Stacheites prionoides*, Kittl, 1903, p. 27, pl. iv, fig. 8.

DIAGNOSIS. Smooth, discoidal, involute Meekoceratids, with only one lateral saddle.

DISTRIBUTION. Upper Eo-trias, Columbitan. Dalmatia.

REMARKS. Kittl was probably wrong in stating that the incompletely known genus *Stacheites* appeared to attach itself

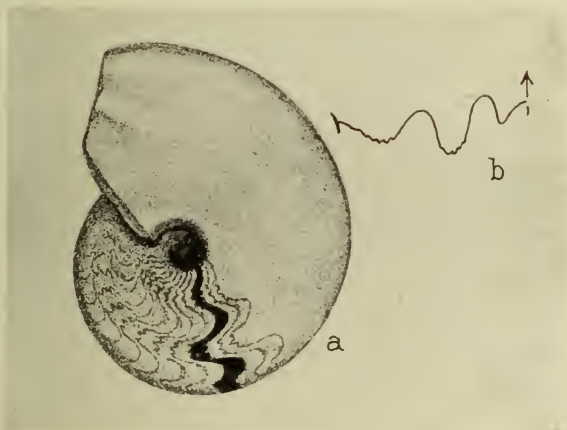


FIG. 92.—*Stacheites prionoides*, Kittl. Side-view and suture-line of holotype from the Upper Eo-trias of Muć, Dalmatia. (After Kittl, 1903, pl. iv, fig. 8.)

to *Dinarites*. The similarity to earlier genera of the Paranoritidæ, etc., is also superficial, as is the resemblance to the Himalayan "*Stacheites*" *webbianus*, Diener (1907, p. 91, pl. v, fig. 6), with spiral ornamentation—apparently an entirely new stock.

Although the unique holotype is poorly preserved, it was considered probable that the siphonal area was bordered by two ventro-lateral edges. This makes it impossible to refer *Stacheites*, with its contemporary *Dalmatites*, to the family Hungaritidæ, as J. P. Smith has done (1932, p. 28). On the other hand, as in the case of *Pseudokymatites*, discussed above, derivation from the Meekoceratidæ, as here understood, is more probable, and, after all, the only essential difference

between *Stacheites* and *Meekoceras* is the reduction in the number of sutural elements of the former, which reduction may occur in any stock.

3. Sub-family DAGNOCERATINÆ, nov.

See p. 254, *supra*.

DIAGNOSIS. More-or-less evolute, smooth or feebly ornamented Meekoceratidæ, with arched or tabulate venters and ceratitic suture-lines, with only one lateral lobe.

REMARKS. As already mentioned, the forms included by Arthaber in his genus *Dagnoceras* comprise a varied congeries of possibly unrelated types, and until the Albanian forms are more completely known, only a provisional classification is possible. Although the genotype, in external shape, is comparable to *Submeekoceras*, especially to the later forms of the *Columbites* Beds, and to certain Flemingitids, its suture-line is quite distinct. It seems advisable to keep this group separate from Arctoceratinæ, with which sub-family *Dagnoceras* had been classed by Arthaber. These two are now included as sub-families in a larger group, Meekoceratidæ, but like Dinaritidæ, they may have originated from separate ("Lecanitid") ancestors, and the continuity of the sequence may be only apparent.

Genus DAGNOCERAS, Arthaber.

1911, p. 240.

GENOLECTOTYPE. *Dagnoceras nopcsanum*, Arthaber, 1911, p. 241, pl. xxi, figs. 6a-c (Diener, 1915a, p. 115).

DIAGNOSIS. More-or-less involute, inflated, discoidal Dagnoceratinæ, with arched venters and greatest whorl-thickness at the umbilical edge. Smooth, or with indistinct folds. Suture-line with only one lateral lobe.

DISTRIBUTION. Upper Eo-trias, Columbitan?. Albania; Timor.

REMARKS. In typical Arctoceratids, as in Meekoceratids, there is a tendency of the saddles to become wide and low, and to assume an aspect which is widely different from that represented by the corresponding elements in Flemingitids or Paranoritids. A similar tendency may be observed in *Dagnoceras nopcsanum*, which, with Diener and contrary to Smith (1932, p. 65), I take to be the genotype, and in *D. lejanum*, Arthaber; *D. zappanense*, Arthaber, is probably closely allied

to these two species. The other forms, however, included by Arthaber in his genus may be sufficiently distinct for generic separation.

There is first of all "*Dagnoceras*" *terbunicum*, Arthaber, which seems to differ entirely from the typical species in its tabulate venter, discoidal shape and suture-line. Yet it cannot be attached to the Meekoceratids, although, like "*Dagnoceras*" *komanum*, Arthaber (wrongly taken by J. P. Smith to be the genotype), it might be compared to "*Goniodiscus*" and the Prionitidæ.¹ There is a resemblance to such forms as

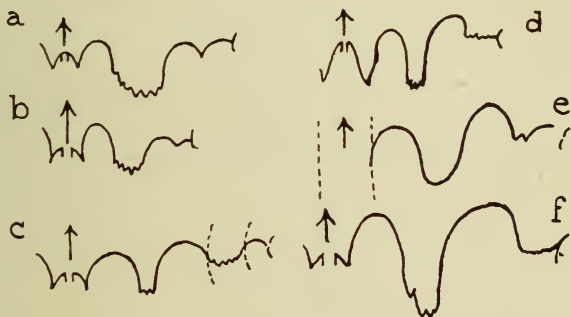


FIG. 93.—Suture-lines of *Dagnoceras*. *a*, *D. nopcsanum*, Arthaber (enlarged $\times 2$). *b*, *D. nopcsanum*, Arthaber, var. *c*, *D. lejanum*, Arthaber (enlarged $\times 2$). *d*, *D. zappanense*, Arthaber (enlarged $\times 2$). All after Arthaber, 1911, pl. xxi, figs. 6c, 7c, 13c and 9b. *e*, *f*, *D. zappanense*, Arthaber. Suture-lines of the two metatypes (B.M., C. 22821-2) referred to on p. 271, enlarged $\times 3$. All from the Upper Eo-trias of Kçira, Albania.

Arthaber's *Albanites* (= "*Pronorites*" of 1911), especially in the notching of the ventral edges; and perhaps also a general resemblance to Sibiritidæ. On examination of the suture-lines it is noticed that Arthaber's fig. 11c (pl. xxi), apart from omitting the details of the external lobe, is out of proportion as regards the spacing of the auxiliary elements. In the projected

¹ Since the above was written, an isolated example of a new species from Timor has been received (C. 33701) which is very close to *Dagnoceras terbunicum*, Arthaber (1911, p. 242, pl. xxi, figs. 10a-c), but has a still wider first lateral lobe. Its general resemblance to *Albanites welteri*, nom. nov., from the same bed (with manganese-coated fossils) is so striking that it was at first believed to be merely a variety, until the different suture-line was exposed. The Timor example was associated with another *Dagnoceras* (C. 33713), which I cannot separate from *D. lejanum*, Arthaber (see p. 278).

drawing these three lobes take up more space than the rest of the suture-line, *i. e.* the lateral lobe and the external and lateral saddles; yet they are to be accommodated on the perpendicular umbilical wall of Arthaber's front view (fig. 11*b*); and if the sectional outline is correct, the auxiliaries include less than one-quarter of the total length of the external suture-line. This, then, cannot be so very different from that of, *e. g.*, *Dagnoceras zappanense*. Again, Arthaber's "*Ophiceras*" has a similar suture-line, and among the metatypes of *Dagnoceras nopcsanum* in the Collection there is at least one that shows two lateral saddles, and, although too imperfect to be definitely identified, resembles "*Ophiceras*" also in its greater compression. It is probable that Arthaber's "*Ophiceras*" may turn out to be close to the primitive stock from which sprang not only the Dagnoceratids and Prionitids, but even the Sibiritidæ, the costate stage in the young being cænogenetic.

Dagnoceras nopcsanum, Arthaber.

Plate VIII, fig. 1.

1911, p. 241, pl. xxi, figs. 6*a-c*.

DIAGNOSIS. Subplatygyral, subpachygyral, sublatumbilicate *Dagnoceras*, with elliptical whorl-section, arched venter, and high and steep umbilical wall with rounded edge. Test smooth, with sigmoidal striæ of growth. Suture-line (fig. 93*a, b*) with one wide lateral lobe only.

MEASUREMENTS:

C. 22827 (Pl. VIII, fig. 1)	.	26	.38	.34	.38
Arthaber, 1911, pl. xxi, fig. 6	.	31 (26	.40	.40	.36

REMARKS. The peripheral view given by Arthaber is so unlike that of any of his metatypes in the Collection that it must be assumed to be incorrect. Not only is his fig. 6*b* too inflated, but fig. 6*a* shows an unnatural increase in whorl-height at the end, which must also be due to faulty drawing. In the form described by Arthaber as *Dagnoceras nopcsanum* var. (figs. 7*a, b*), the inflation is probably similarly exaggerated. The characteristic suture-line allows the well-preserved examples to be easily distinguished from the similar "*Ophiceras sakuntala*" described by Arthaber, which may be transitional between the Dagnoceratids and *Submeekoceras* or such Flemingitids as *Pseudoflemingites* and *Flemingites ? russelli*, Hyatt and

Smith, but which is merely a homœomorph of the early true *Ophiceras sakuntala* (Diener), described above.

The two species described below are more involute and less smooth.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ? Albania.

SPECIMENS :

C. 22824-9. Kčira, Albania. Baron F. Nopcsa Coll., 1922.

Dagnoceras zappanense, Arthaber.

Plate VII, fig. 2.

1911, p. 241, pl. xxi, figs. 9a, b (holotype), 8a, b.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Dagnoceras*. Distinguished from last by smaller umbilicus and less simple suture-line (figs. 93d-f).

MEASUREMENTS :

Arthaber, pl. xxi, figs. 8 (9) . 37.5 (34) . 46 (.39) .24

REMARKS. One of the metatypes in the Collection, the suture-line of which is here figured (fig. 93e), shows an entire lateral lobe. This, however, may be due to abrasion from excessive preparation. The appearance of the ventral lobe in another metatype (fig. 93f) may also be due to abrasion, and it may be assumed that the varying aspect of this lobe in Arthaber's drawings can also be accounted for in this way. On the other hand, *D. zappanense*, like *D. lejanum*, has a narrower lateral lobe than *D. nopcsanum*, and even different saddles. The former species is more evolute than *D. zappanense*, and the plications are more distinctly marked round the umbilical edge. *D. nopcsanum* is more evolute and smooth.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ? Albania.

SPECIMENS :

C. 22821-3. Kčira, Albania. Baron F. Nopcsa Coll., 1922.

Dagnoceras lejanum, Arthaber.

1911, p. 242, pl. xxi, figs. 13a-c (holotype), figs. 12a, b.

DIAGNOSIS. *Dagnoceras* with subplatygyral, subleptogyral, subangustumbilicate coiling. Like *D. zappanense* and *D. nopcsanum* in general whorl-shape, but with blunt, subtuberculate

folds at the umbilical edge. Suture-line with narrow L (see fig. 93c).

MEASUREMENTS :

Arthaber, pl. xxi, figs. 13a, b . 42 .40 .29 .31

REMARKS. In umbilication this species is intermediate between *D. nopcsanum* and *D. zappanense*. The suture-line has a narrow lateral lobe, like that of the latter species, but the saddles are plumper.

Arthaber considered that its ornamentation indicated affinity with the similarly tuberculate *Prionites*. This, however, seems doubtful, although *Prionites* shows transitions to the Arco-ceratids, with which Arthaber had united the genus *Dagnoceras*.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?. Albania; Timor.

SPECIMENS :

- C. 22830-1. Kçira, Albania. *Baron F. Nopcsa Coll.*, 1922.
C. 33713. Nifoekoko, Timor. *M. E. Walsh Coll.*, 1930.

INCERTÆ SEDIS.

Genus **PROAVITES**, Arthaber.

1896, p. 104; Diener, 1915a, p. 228; Kutassy, 1933, p. 622.

GENOTYPE. *P. hueffeli*, Arthaber, 1896, p. 104, pl. x, fig. 2.

DIAGNOSIS. Smooth, discoidal, sometimes greatly inflated ammonites, possibly Meekoceratids, with tabulate venter, bordered by two distinct edges. Suture-line goniatic, with deep and comparatively large, first lateral lobe.

DISTRIBUTION. Uppermost Eo-trias and Anisian.

REMARKS. Only three of the thirteen species listed by Diener are referable to this genus, but *P. benigni*, Kraus (1916, p. 59, pl. x, figs. 8a-c), is an interesting additional form. *Proavites* has no relationship with *Lecanites*, of which J. P. Smith (1932, p. 31) thought it a possible synonym; but that author was probably right when elsewhere (p. 40) he called *Proavites* merely a degenerate descendent of the Meekoceratidæ.

Lecanites sisupala, Diener (1897, p. 147, pl. xxiii, fig. 3), which may be some Flemingitid or Gyronitid, seems to me less closely allied to *Proavites* than such forms as *Dagnoceras terbunicum*, Arthaber (1911, pl. xxi, fig. 10); on the other hand, affinity with the family Noritidæ, described below, is not so improbable as the comparison of the adult suture-lines might suggest.

Proavites hueffeli, Arthaber.

Fig. 94.

1896, p. 104, pl. x, figs. 2a-d ; Diener, 1915a, p. 228.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Proavites*, with umbilical wall more vertical than in *P. avitus* and tabulate venter wider than in *P. marginatus*, Arthaber.

MEASUREMENTS :

Holotype (Arthaber)	. 40	. 50	. 35	. 18
C. 37194	. 70	. 47	. 28	. 19

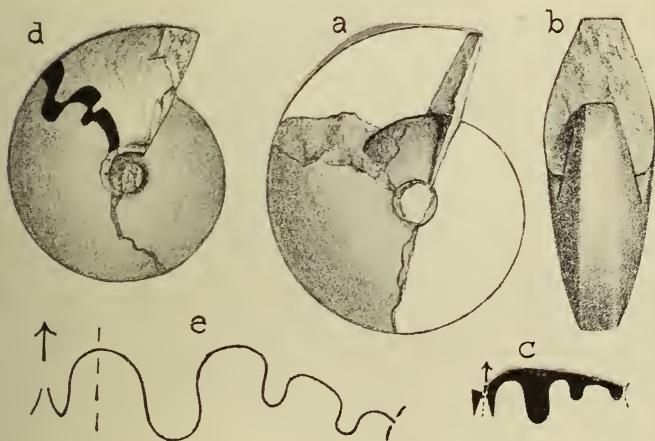


FIG. 94.—a-c, *Proavites hueffeli*, Arthaber, and d, *P. avitus*, Arthaber. Anisian, Reifling Limestone. (After Arthaber, 1896, pl. x, figs. 2a, b, d, 3a.) e, External suture-line (enlarged $\times 3$) of *P. hueffeli* (B.M., C. 37194), Stavljan, Bosnia.

REMARKS. The only example in the Collection, the first typical *Proavites* recorded from the Bosnian-Montenegrin Trias, consists of only half an ammonite, like the holotype, but it well shows the suture-line on the inner whorls, while the outer half whorl belongs to the body-chamber. The specimen thus is probably the largest *Proavites* so far found. The suture-line here figured may be thought to show as much resemblance to that of *P. avitus*, and especially to that of *P. marginatus*,

Arthaber (1896, p. 105, pl. x, figs. 3-4), as to that of *P. hneffeli*, but the differences are scarcely specific. The Bosnian *P. benigari*, Kraus, already cited, differs from the form here described, not only in its inflated whorl-shape, but also in having a very deep external lobe.

HORIZON AND LOCALITIES. Anisian, *trinodosus* zone. Alps; Balkans.

SPECIMENS :

C. 37194. Mali Durmitor Mts., Montenegro.

V. Hawelka Coll., 1926.

k. Family NORITIDÆ, Karpinsky emend.

1889, p. 45.

DIAGNOSIS. Smooth, flat and discoidal ammonites, with tabulate peripheries, generally bordered by two pronounced edges. Suture-lines ceratitic, with club-shaped saddles, and the first lateral lobe more-or-less symmetrically subdivided.

REMARKS. Most authors still connect the Noritidæ with the Palæozoic Pronoritidæ, as was done by Karpinsky, Waagen (1895, p. 148) and Hyatt (1900, p. 562); and in his latest classification J. P. Smith (1932, p. 35) similarly considers *Albanites* to be a probable derivative of the Permian *Daraelites*, although he (probably correctly) took *Albanites* to be the direct ancestor of the Middle Triassic Noritidæ. But in view of the late age of *Albanites* it seems to me much more reasonable to derive the Noritids from the Meekoceratidæ, and especially the Dagnoceratidæ, described above. The suture-line of *Albanites* does not differ essentially from that of Arthaber's "*Pseudosibirites*" (*Anasibirites*) cfr. *dichotomus*, Waagen, and resembles that of the Albanian "*Meekoceras*" *skrodense*, Arthaber (1911, p. 247, pl. xxi, fig. 15), possibly another Prionitid, at least as much as it resembles that of the Palæozoic genera. In external characters the Timor *Albanites welteri* is almost indistinguishable from the Salt Range *Hemiprionites* ("*Goniodiscus*") *typus* (Waagen), but in suture-line the Dagnoceratids are perhaps closer.

There is no connection in my opinion between the Noritids and the Pinacoceratidæ (*ex* Gymnitidæ); but the position of *Ananorites*, based on a single fragment, is as yet doubtful.

Genus **ALBANITES**, Arthaber.

1909, p. 232 (= *Pronorites*, Arthaber, *non* Mojsisovics, 1911, p. 204).

GENOTYPE. *Pronorites triadicus*, Arthaber, 1908, p. 264, pl. xi, figs. 4a-c (= 1911, pl. xvii, figs. 8, 9).

DIAGNOSIS. More-or-less involute, smooth or faintly ribbed Noritidæ, with flattened sides and tabulate venter, occasionally transversely costate. Suture-line with more club-shaped saddles than in externally similar Prionitids (and Sibiritids) and with subdivided L.

DISTRIBUTION. Upper Eo-trias, Columbitan ?. Albania ; Timor.



FIG. 95.—*Albanites triadicus* (Arthaber). Side- and peripheral views of holotype. Lower Trias. Albania. (After Arthaber, 1911, pl. xvii, figs. 8a, b.)

REMARKS. *Albanites* probably has an independent origin in the Meekoceratids or Dagnoceratids, from one of which the Prionitids and Sibiritids described below were also derived ; and its suture-line is reminiscent of that of such forms as "*Meekoceras*" *paucesculptatum*, Welter (1922, p. 128, pl. clxv, figs. 16, 17), and "*Aspidites*" *hasserti*, Arthaber (1911, p. 249, pl. xxi, figs. 16a-c), which may belong to a hitherto un-named genus. The suture-line of the latter species, however, apart from the external lobe, obviously diagrammatically drawn in Arthaber's figures, agrees with that of Arthaber's "*Dagnoceras*" *komanum* (1911, p. 242, pl. xxi, fig. 11c), already referred to (*supra*, p. 269), and this form has notching of the edges of the tabulate periphery, as well as the whorl-shape of certain Prionitids. Again, the new Timor species figured by Welter (1922, pl. clv, fig. 9, text-fig. 4, on p. 95) does not support Arthaber's view of the connection

of *Albanites* with the Palæozoic *Pronorites*. Diener (1915*b*, p. 16) has shown that there is no adventitious lobe in Arthaber's Anisian Noritids, but, whilst directing attention to the similarity between the Himalayan *Anasibirites spiniger* (v. Krafft) and *Albanites arbanus*, he considered the other species of *Albanites* to be generically inseparable from *Noritites*—at least on the basis of the suture-line. But since the Albanian species seem closely allied, it appears preferable to unite them in one genus; and although ornamentation and whorl-shape are somewhat different from what is found in the true *Noritites*, the Albanian stock is here referred to the Noritids.

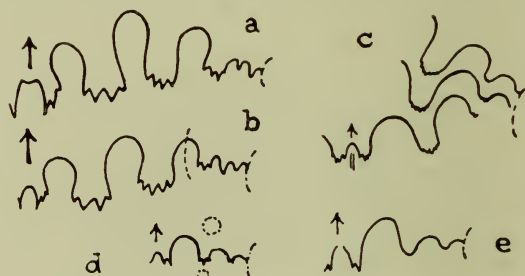


FIG. 96.—Suture-lines of *a*, *Albanites triadicus* (Arthaber) and *b*, *A. arbanus* (Arthaber), enlarged $\times 2$. Lower Trias. Albania. (After Arthaber, 1911, pl. xvii, figs. 9 and 11*d*.) *c*, *Stephanites superbus* (Waagen). Lower Trias. Salt Range. (After Frech, 'Lethæa Geognostica', 1905, pl. xxviii, fig. 1.) *d*, ? *Durgaites* (*Anastephanites*) *meridianus* (Welter). Lower ? Trias. Bihati, Timor. (After Welter, 1922, pl. clxviii, fig. 17 = ["*Tirolites*"].) *e*, "*Sibirites*" (? *Durgaites*) *prahlada*, Diener. Middle Trias. Shalshal Cliff, near Rimkin Paiar, Himalayas. (After Diener, 1895*b*, pl. vii, fig. 5*d*.)

Albanites osmanicus (Arthaber).

1911. *Pronorites osmanicus*, Arthaber, p. 205, pl. xvii, figs. 10*a-c*.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Albanites*. Sides flattened, venter subtabulate, whorl-shape subquadrate, especially on the outer whorls, with high umbilical wall. With transverse ribs on periphery and faint costation on sides. Suture-line with wide, subdivided L and low external lobe (compare fig. 96*a, b*).

MEASUREMENTS :

Holotype (Arthaber, pl. xvii,

fig. 10)	40	45	40	25
C. 22833	31	48	45	27

REMARKS. One of the examples in the Collection shows the suture-line, obtained by grinding down the surface; and in this the saddles are seen to be broader than those drawn by Arthaber. As his figure 10a shows, the saddles are "telescoped" and give the impression of unusual length, whilst they are not appreciably slenderer than those of *A. arbanus*. There is no resemblance in suture-line to *Anasibirites*, and Arthaber stated that the similarity of the species here described to the rectecostati of the Salt Range was purely external; but he adduced as evidence the absence in the latter of adventitious elements, whilst I would consider the unusual depth of the external lobe to be the principal difference between *Albanites* and any of the Dagnoceratids (and other incompletely known forms) figured in Arthaber's (1911) pl. xxi.

The two specimens listed below were included among the metatypes of *A. arbanus*; but that species differs in its smaller umbilicus and flatter whorl-shape. *A. triadicus*, Arthaber, has a smooth ventral area.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?. Albania.

SPECIMENS :

C. 22832-3. Kčira, Albania. *Baron F. Nopcsa Coll.*, 1922.

Albanites arbanus (Arthaber).

1911. *Pronorites arbanus*, Arthaber, 1911, p. 205, pl. xvii, figs. 11a-d (12a, b ?).

DIAGNOSIS. Platygyral, subleptogyral, angustumbilicate *Albanites*. Sides flattened, smooth; venter tabulate, with transverse ribs, slightly projecting over the ventro-lateral edges in the adult; inner whorls with delicate, falcoid striæ. Umbilical edge abrupt, undercut. Suture-line as in *P. osmanicus*, but with L as deep or deeper than E (fig. 96b).

MEASUREMENTS :

Arthaber, 1911, p. 205, No. I

(corrected) 23 .50 .30 .15

C. 22837 20 .53 .30 .15

REMARKS. This species, as already mentioned, differs from the last chiefly in its compressed whorl-shape and smaller umbilicus; but the slightly different proportions of the elements of the suture-line (with general similarity) are, perhaps, of greater significance. There is such good agreement with the

suture-line of *A. triadicus*, the genotype, that generic separation is impossible. But the resemblance of the last to *Norites* is not very close, if the suture-line given by Arthaber (1911, pl. xvii, fig. 9) is drawn as accurately as he declares; and *Norites* might even be taken to be an involute development of the Anisian *Ananorites*, Diener, which he significantly placed with *Gymnites* in the family Pinacoceratidæ.

Welter (1922, p. 95) already considered it doubtful whether Arthaber's fig. 12 represented a fully-grown individual of the smaller immature lectotype (fig. 11), and his two specimens from Timor (pl. clv, figs. 10-14) may be identical, the forward curve of the peripheral ribs being quite as distinct in the Albanian forms.

The three poorly preserved specimens from Kčira, listed below as doubtful, seem to be somewhat intermediate between the present species and *A. osmanicus*.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?. Albania; Timor.

SPECIMENS :

C. 22837, ? 22834-6. Kčira, Albania.

Baron F. Nopcsa Coll., 1922.

Albanites welteri, nom. nov.

1922. *Pronorites arbanus*, non Arthaber; Welter, p. 94, pl. clv, figs. 10-14.

DIAGNOSIS. Subplatygyral, subleptogyral to subpachygyral, subangustumbilicate *Albanites*. Whorl-section compressed rectangular, with flattened sides and tabulate venter, and high, and almost perpendicular, umbilical wall. With indistinct sigmoidal folds in young, with ridges across periphery; with falcoid striation on body-chambers. Suture-line as in *A. triadicus* (fig. 96a), but with external first and second lateral lobes more distinctly ascending and second lateral saddle broader and rounder.

MEASUREMENTS :

Welter, figs. 10-12	.	.	33	.	48	.	36	.	18
„ figs. 13, 14	.	.	28	.	50	.	30	.	16
C. 33702	.	.	57	.	46	.	35	.	21

REMARKS. The specimen from Timor figured by Welter as *Pronorites* spec. ind. ex aff. *arbanus*, Arthaber (p. 95, pl. clv, fig. 9, text-fig. 4), is apparently merely a fully grown example of the present species, judging by six very fine specimens in the

Walsh Collection, and five more, smaller, but equally typical examples. Welter's measurements of both whorl-height and umbilicus appear to be wrong, probably on account of misprints in the figures. The length of the body-chamber is just half of the outer whorl, and the aperture was plain, following the sigmoidal curve of the striation, with a slightly projected ventral lappet, and being gently flared on the inner half of the whorl-side. The external resemblance to *Albanites arbanus* (Arthaber) is considerable, but the suture-lines are somewhat different.

HORIZON AND LOCALITIES. Upper Eo-trias (bed with manganese-coated fossils). Timor.

SPECIMENS :

C. 33702-12. Nifoekoko.

M. E. Walsh Coll., 1930.

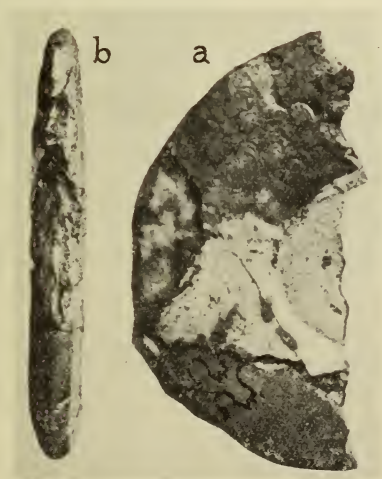


FIG. 97.—*Ananorites monticola*, Diener. Upper Anisian. Bambanag Cliff, Himalayas. (After Diener, 1907, pl. xii, figs. 5a, b.)

Genus ANANORITES, Diener.

1907, p. 103 (as sub-genus of *Norites*).

GENOTYPE. *A. monticola*, Diener, 1907, p. 10, pl. xii, fig. 5.

DIAGNOSIS. Smooth, discoidal Noritidæ with sharp marginal edges of the periphery developing at a comparatively late stage. Suture-line with shallow external lobe and broad umbilical lobe, showing many auxiliary indentations.

DISTRIBUTION.—Anisian. Himalayas.

REMARKS. This genus is included in the Noritidæ entirely on Diener's authority; but although he considered it to be merely a sub-genus of *Norites*, size alone seems to me to be against this association. The fact that the first lateral lobe is subdivided by a median leaflet need not necessarily be decisive, if all the other characters point to affinity with *Gymnites*; such anomalies are constantly met with in the homogeneous Ammonoidea. And since the genotype is only known in a single, fragmentary individual, the systematic position of *Ananorites* must remain uncertain. Moreover, it is as little connected with *Norites* by transitional forms as is *Albanites*.

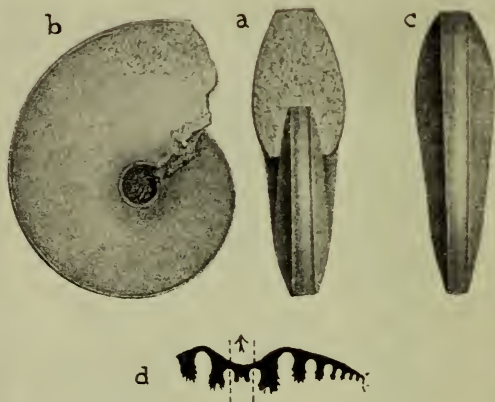


FIG. 98.—*Norites gondola*, Mojsisovics. Inflated and slender examples. Anisian. Schreyer Alm, Gosau. (After Mojsisovics, 1882, pl. lii, figs. 6a, b and 8a, b.)

Genus **NORITES**, Mojsisovics.

1878, p. 48; 1879, p. 135.

GENOTYPE. *Ammonites gondola*, Mojsisovics, 1869, p. 584, pl. xv, fig. 3.

DIAGNOSIS. Involute Noritids with marginal keels of periphery well developed, also sharp, umbilical edge. External saddle comparatively small, but external lobe shorter or longer than first lateral.

DISTRIBUTION. Anisian, Ladinian. Alps; Balkans; Greece.

REMARKS. The association by Haug and Mojsisovics of *Norites* with *Tellerites* (see p. 225) seems to me less tenable than the comparison to *Sageceras* (Griesbach and Hyatt, 1883); but in 1900, Hyatt put *Sageceras* and *Norites* into widely distinct sub-orders. Diener (1915*b*, p. 16) also agreed that *Albanites* and *Norites* were very closely allied, or even identical, and the resemblance to *Sageceras* may not be of any significance.

Norites gondola (Mojsisovics).

Fig. 98.

1869, as above (*Ammonites*); Diener, 1915*a*, p. 210; Kutassy, 1933, p. 601.

DIAGNOSIS. As for genus.

MEASUREMENTS :

Holotype	25	. 56	. 28	. 12
Mojsisovics, 1882, pl. lii, fig. 6	37	. 51	. 32	. 11
Kraus, 1916, p. 19 [255]	20.5	. 49	. 29	. 15

REMARKS. The various species of *Norites* listed in Diener differ only slightly, chiefly in cross-section, but at the small diameter of some of the examples recorded below, specific separation from the common *N. gondola* does not seem justified or necessary. Some of the more compressed specimens were at first believed to belong to that slender variety, mentioned by Mojsisovics (1882, p. 202, 1902, p. 312), in which the median line of the periphery may be raised, as in *N. subcarinatus*, Hauer (1887, p. 31, pl. vii, fig. 7); but they turned out to be *Arthaberites* when the suture-line was exposed.

HORIZON AND LOCALITIES. Anisian. Alps; Bosnia, etc.; Greece; Timor.

SPECIMENS :

- C. 5455-6, 5458. Schreyer Alm, Hallstatt.
E. v. Mojsisovics Coll., 1889.
 C. 13896. Hierlatz, Dachstein. *Purchased*, 1911.
 C. 20350-52, 21037-9. Stavljan, Volujak Mts., Bosnia.
V. Hawelka Coll., 1908.
 C. 23063. Gimaj, Albania. *Baron F. Nopcsa Coll.*, 1922.
 C. 37191, 37206. Toeboelopo (block with *Parasageceras*), Timor.
M. E. Walsh Coll., 1930.

Genus **ARTHABERITES**, Diener.

1900, p. 17 ; 1915*a*, p. 59 ; Kutassy, 1933, p. 428.

GENOTYPE. *A. alexandræ*, Diener, 1900, p. 18, pl. ii, fig. 4.

DIAGNOSIS. Comparatively large, discoidal and compressed Noritids, with suture-lines resembling those of *Pseudosageceras* or *Cordillerites*.

DISTRIBUTION. Anisian. Alps ; Balkans.

REMARKS. As Diener (1915*b*, p. 39) stated, there is considerable difference of opinion on the systematic position of this genus, but on the whole the evidence points to affinity with Noritidæ rather than Sageceratidæ or Carnitidæ. *Albanites osmanicus* (Arthaber) has somewhat similar lobes, with the second deeper than the first, and although in text-fig. 99*c*, p. 283, the deepest lobe is taken to be the first lateral (after Diener), the ontogenetic evidence for this is as yet wanting. Again, the multiplication of the elements is due merely to the more discoidal whorl-shape and small umbilicus.

Arthaberites alexandræ, Diener.

Fig. 99.

1900, as above.

DIAGNOSIS. Smooth, platycone *Arthaberites*, with very high, compressed whorls and very narrow umbilicus. Greatest thickness at about inner third of whorl-side, which rounds off into perpendicular umbilical wall, on the one hand, and, on the other, is only very gently convex up to the sharp peripheral edges which border the tabulate venter. Suture-line (fig. 99*c*, p. 283) with an adventitious lobe of unusual width and a prominent leaflet on the outer side of what is taken to be L.

MEASUREMENTS :

Holotype (Diener, 1900)	.	54	.	·56	.	·21	.	·09
C. 20341	.	72	.	·54	.	·21	.	·11

REMARKS. As Kraus (1916, p. 21 [257]) has shown, there is no specific difference between *A. alexandræ* from the Schiechling Höhe, and the Bosnian *A. katzeri*, Turina (1912, p. 689, pl. xlii, figs. 1*a-c*, 2*a, b*). The smaller examples listed below were at first taken to be compressed individuals of *Noritæ*,

and the grinding down of the usual manganese-coated surface of the Bosnian and Montenegrin specimens unfortunately often results in the obliteration of the details of the suture-line. This, however, is quite unmistakable even in the most immature examples.

HORIZON AND LOCALITIES. Anisian. Alps; Bosnia; Montenegro; Albania.

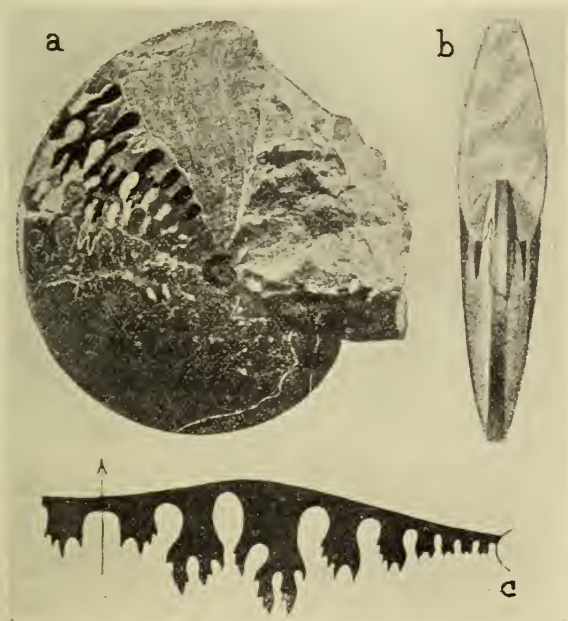


FIG. 99.—*Arthaberites alexandræ*, Diener. Anisian, *trinodosus* zone. Schiechling, near Hallstatt. (After Arthaber, 1911, fig. 9, p. 217.)

SPECIMENS :

- C. 5420.** Schreyer Alm, Hallstatt. *E. v. Mojsisovics Coll.*, 1889.
C. 20341, 21035, 21040. Stavljan, Volujak Mts., Bosnia.
V. Hawelka Coll., 1908.
C. 21060. Suha, on the Sutjeska, Bosnia. *Same Coll.*
C. 37195–203. Mali-Durmitor Mts., Montenegro.
V. Hawelka Coll., 1926.

IV. Super-family PHYLLOCERATIDA, Hyatt.

DIAGNOSIS. Smooth or feebly ornamented derivatives of the Meekoceratida, in which the entire ceratitic saddles and, on further complication, the minor branches of the saddles become leaf-like (phylloid).

REMARKS. Hyatt divided this super-family, corresponding more or less to Zittel's original (1884) family Phylloceratidæ, into three families, Megaphyllitidæ, Ussuritidæ and Phylloceratidæ, s.s., but in 1914 (p. 358) I suggested that *Megaphyllites* was not connected with the Monophyllitidæ. Having wrongly transferred *Ussurites*, which is a typical Monophyllitid, to the family Thalassoceratidæ, together with the very distinct genus *Ussuria* (see p. 212), I then ranged the Triassic genera partly with Monophyllitidæ and partly with Phylloceratidæ, but the family Pleuracanthitidæ, Hyatt emend. Diener, which I had also provisionally classed with the super-family Phylloceratida, I later (1919, p. 221) considered should be abandoned. In 1927 (p. 37) I separated the Discophyllitinæ as a sub-family from the Phylloceratidæ; but the Discophyllitidæ are now taken to be an independent family, so that the Phylloceratidæ, in the restricted sense, are entirely post-Triassic.

A. Family MONOPHYLLITIDÆ, Smith emend.

J. Perrin Smith, in Zittel-Eastman, 2nd edition, 1913, p. 651; Spath, 1914, p. 359.

DIAGNOSIS. Discoidal, evolute ammonites, with rounded venters and generally little or no ornamentation. Suture-lines with primitive monophyllic saddles and lituid internal lobe.

REMARKS. It has already been mentioned that the derivation of Monophyllitids from *Dimorphoceras*, through the Permian Thalassoceratidæ and *Ussuria*, cannot be upheld. Such series may look convincing enough, on paper, if represented by certain selected suture-lines; but a study of the enormous wealth of Eo-triassic and Permian ammonoids shows that these two periods must have been of very long duration. It is simple to pick out certain species of widely separated geological

horizons in these two ages, and arrange these forms in series, merely on account of some supposed progressively elaborating feature of the suture-line; but the monophyllic type of saddle recurs particularly often, and in such a number of stocks, that many alternative series could be arranged, as convincing as the one mentioned. Arthaber's inclusion of Monophyllitids and Flemingitids into one sub-family (Gymnitinæ), and of these with Proptychitids into the same family (Ptychitidæ), even if not here accepted and later (1927, p. 138) retracted by Arthaber himself, shows that the resemblance in the suture-lines of these Eo-triassic stocks had not been overlooked. It seems probable that the Ophiceratid-Gyronitid stock that produced such specialized groups as Flemingitids also gave rise to the less ornamented Monophyllitids. Griesbach (1880, p. 109) had already suggested that *Monophyllites* may be derived from *Ophiceras*, but Mojsisovics (1882, p. 205) went further back to the Carboniferous *Pronorites*.

The genera now included in this family comprise *Monophyllites*, *Ussurites*, *Eophyllites* (recently proposed for the Albanian Eo-triassic forms with suture-lines closer to those of Flemingitids and Proptychitids than to the typical *Monophyllites*, s.s.), *Palæophyllites*, *Leiophyllites*, *Mojsvarites* and *Eopsiloceras* (for *Amm. planorboides*, Gümbel). All the genera of the present family are well represented in the Collection.

Genus **MONOPHYLLITES**, Mojsisovics.

1879, p. 135; 1902, p. 315; Diener, 1915*a*, p. 203; Arthaber, 1927, p. 137.

GENOTYPE. *Ammonites sphærophyllus*, Hauer, 1850, p. 113, pl. xviii, fig. 11.

DIAGNOSIS. Evolute, discoidal Monophyllitidæ, with rounded whorl-section, arched venter and sigmoidal striæ of growth. Suture-line with irregularly trifid L, four or more monophyllic saddles, rounded at first, but tending later to become narrow towards top; external saddle with few lateral leaflets.

DISTRIBUTION. Base of Middle Trias (Lower Anisian) to Lower Neo-trias (Upper Carnian).

REMARKS. Of the two groups of *Monophyllites suessi* and *M. sphærophyllus*, accepted by authors for more than twenty years, the latter was selected by its author (Mojsisovics, 1902, p. 316) as typical. With Diener, we must therefore accept

M. sphærophyllus as genotype, not *M. suessi*, Mojsisovics, selected later by Hyatt and Smith (1905, p. 93). The latter species has now been taken by Diener (1916, p. 102) to be the type of his sub-genus *Leiophyllites*. Like *Ussurites*, with simpler suture-line, and *Mojsvarites*, with more subdivided saddles, *Leiophyllites*, with its short, plump saddles and simple lobes, is here considered to be of independent generic rank.



FIG. 100.—Suture-lines of *Monophyllites* and *Ussurites*. *a*, *Monophyllites simonyi* (Hauer). Lower Carnian, Hallstatt. (After Mojsisovics, 1873, pl. xvii, fig. 6.) *b*, *M. sphærophyllus* (Hauer). Anisian. Venetian Alps. (After Mojsisovics, 1882, pl. lxxix, fig. 3c.) *c*, *e*, *M. sphærophyllus* (Hauer). Albania. Internal suture-lines of adult (enlarged $\times 2$) and immature (enlarged $\times 3$) examples, C. 23067b and *a*. *d*, *M. simonyi* (Hauer). Röthelstein. Complete suture-line at 3 mm. diameter, enlarged. (After Branco, 1879, pl. viii, fig. vm.) *f*, *M. wengensis* (Klipstein). Ladinian. Hungary. (After Diener, 1899, pl. i, fig. 4.) *g*, *M. aonis*, Mojsisovics. Lower Carnian, Rumania. (After Mojsisovics, 1882, pl. lxxviii, fig. 5c.) *h*, *Ussurites* (?) *spetsbergensis* (Öberg). Anisian. Spitsbergen. (Oxf. Univ. Exp., 1921, slightly enlarged.) *i*, *U. billingsianus* (Gabb). Anisian. Nevada. (After J. P. Smith, 1914, pl. v, fig. 4.) *j*, *U. hara* (Diener). Anisian. Himalayas. (After Diener, 1895, pl. xxxi, fig. 9c.) *k*, *U. sichoticus* (Diener). Anisian. Ussuri, Siberia. (After Diener, 1895a, pl. v, fig. 1c.) (Figs. *a*, *b*, *d*, *f*, *g*, *i*, *j* *k* are copies reduced to $\frac{2}{3}$ linear.)

Monophyllites sphærophyllus (Hauer).

1850, p. 113, pl. xviii, fig. 11; Diener, 1915*a*, p. 204; Kraus, 1916, p. 288; Gugenberger, 1927, p. 125; Kutassy, 1933, p. 593.

DIAGNOSIS. Subplatygyral, subleptogyral, sublatumbilicate *Monophyllites*. Whorl-section compressed, with slightly flattened sides and arched venter; striæ of growth almost radial on side, projected peripherally. Suture-line with rounded external and spatulate lateral saddles and three sub-bifid lateral lobes. (fig. 100*b*, *c*, *e*).

MEASUREMENTS :

Mojsisovics, 1882, pl. lxxix,

figs. 1 <i>a</i> , <i>b</i>	.	.	.	130	·43	·27	·32
C. 21274 (Bosnia)	.	.	.	220	·43	·26	·30
C. 21272 („)	.	.	.	165 (150)	·41	·30	·34
C. 20358 („)	.	.	.	50	·38	·32 ?	·36
C. 7084a („)	.	.	.	170	·40	·30	·33

REMARKS. This well-known species differs from “*M.*” *spetsbergensis* (Oeberg) merely in its slightly more advanced suture-line and in its smaller umbilicus, already obvious in small examples. *M. wengensis* (Klipstein) has coarser and more flexiradiate striation; but there are numerous forms transitional to the later species; and in at least one example of the present form (C. 21145) the striæ are considerably projected and the folds are thickened on the periphery of the test, but not on the cast. The Japanese examples recently described by Yabe and Shimizu (1927, p. 110, pl. xii, figs. 1–6) as *M. cfr. wengensis* also probably belong to the present species. The forms of *Ussurites* are distinguished from similar examples of the present species by their simpler suture-lines.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Alps; Bosnia; Albania; Greece; Roumania; Himalayas.

SPECIMENS :

C. 5419, 5422a, b, 5444, 5462, 5505. Schreyer Alm, near Hallstatt, Austria. *Mojsisovics Coll.*, 1889.

C. 5523a, b, 5539. Schiechling Höhe, near Hallstatt, Austria. *Same Coll.*

C. 13698. Same locality. *Purchased*, 1910.

C. 13895. Hierlatz, Dachstein, Austria. *Purchased*, 1911.

C. 23066–67a, b, 23068–9, 23028. Gimaj, Albania. *Baron F. Nopcsa Coll.*, 1922.

C. 7084a-m. Haliluci, near Sarajevo, Bosnia.

Exch. Prof. K. A. v. Zittel, 1898.

C. 20357-8, 20442, 21114-51, 21176-9, 21272-305. Stavljan, Volujak Mountains, Bosnia. *V. Hawelka Coll.*, 1906-08.

(These, with numerous duplicates, constitute the 314 examples of the present species referred to in Spath, 1921, p. 348, footnote 4).

C. 26941. Sassen Bay, Spitsbergen.

J. W. Gregory Coll., 1896.

(A crushed impression, referred to in Spath, 1921, pp. 348 and 350.)

C. 28572-619, 30934-6. Mali-Durmitor Mountains, Monte-negro. *V. Hawelka Coll.*, 1926.

Monophyllites wengensis (Klipstein).

Plate XVII, fig. 4.

1845, p. 120, pl. vi, fig. 11 ; Diener, 1915a, p. 205 ; Kutassy, 1933, p. 594.

DIAGNOSIS. Subplatygyral, subleptogyral, sublatumbilicate *Monophyllites*. Whorl-section as in previous species ; striæ of growth coarser than in *M. sphærophyllus*, and considerably projected peripherally ; with labial ridges on inner whorls. Suture-line with lateral lobes slightly more subdivided than in this species (see fig. 100f, p. 286).

MEASUREMENTS :

Holotype (Pl. XVII, fig. 4)	.	70 (58)	·43	(?)	·35
Böckh (1873, p. 172)	.	.	32	·41	·34 ·37

REMARKS. Klipstein's original drawing was diagrammatic, but he directed attention to the regular, close, sharp and raised striæ that characterize this species. Klipstein, however, stated that these striæ continued across the venter with a very flat curve, whereas on the periphery of the holotype (at the beginning of the smooth cast of the body-chamber) there is preserved a fragment of the test, showing strongly projected striæ. Böckh also compared the ornamentation of his Hungarian examples (described as *Phylloceras böckhi*, Mojsisovics) to that of *Monophyllites simonyi* (Hauer). The differences of the present species from *M. aonis*, Mojsisovics, discussed below, are then reduced to the supposed absence of folds in the latter, but in young *M. sphærophyllus* there is great variability in this character, and the example of *M. aonis* described below, although presumably it has no labial ridges, still shows folds at a diameter

(35 mm.) at which they seem to have disappeared in the holotype of *M. wengensis*. Since Mojsisovics, however, appears to have had typical specimens of Klipstein's species (especially 1873, pl. xvii, fig. 7) from the black shales with *Daonella lommeli* of the neighbourhood of St. Cassian, it is with some diffidence that we suggest that the example from the Marmolata Limestone, figured by that author in 1882 (pl. lxxviii, fig. 10), belongs to *M. sphærophyllus* rather than to *M. wengensis*; that of his specimens of *M. aonis*, the largest (fig. 5) is transitional from *M. wengensis* to *M. simonyi*, with the suture-line of the former, but the external aspect of the latter; that his fig. 4, if not identical with 5, may be the true *M. wengensis*; and that fig. 3, with the striæ still less projected, must be taken as type of *M. aonis*, if that species is to be retained.

The Greek example of *M. wengensis* figured by Renz (1911, p. 46, pl. iii, figs. 1a, b) shows slightly less projected striation; so does the similar *M. argolicus*, Renz emend, which, in its broader venter and peripheral ridges, differs considerably more from Klipstein's type than does *M. aonis*.

The example from Spitsbergen previously (Spath, 1921, p. 351) recorded, and two other specimens collected in that year by the Oxford University Expedition, are now referred to *Ussurites? spetsbergensis* (p. 300). They have the striation of the present species, but in the presence of folds resemble the small example figured by Mojsisovics (1882, pl. lxxviii, fig. 10), and referred to above as possibly closer to *M. sphærophyllus*.

The Japanese *Monophyllites* cf. *wengensis*, lately recorded by Yabe and Shimizu (1927, p. 110, pl. xii, figs. 1-6), may also well be referred to *M. sphærophyllus*.

HORIZON AND LOCALITIES. Upper Meso-trias, Ladinian. Alps; Hungary; Roumania; Greece.

SPECIMENS:

82982. Wengen, Tyrol. Holotype. *Klipstein Coll.*, 1851.

Monophyllites aonis, Mojsisovics emend.

1882, p. 208, pl. lxxviii, fig. 3 only (lectotype).

DIAGNOSIS. Like *M. wengensis*, but with striæ less projected peripherally. Suture-line, see fig. 100g, p. 286.

MEASUREMENTS:

Mojsisovics, pl. lxxviii, fig. 3 ("aon zone")

	48	38	31	35
C. 5579 ("aonoides zone")	41	39	31	34

REMARKS. The present species was characterized by its author as the connecting link between the older *M. wengensis* and the younger *M. simonyi*. Whilst retaining the suture-line of the former species, the external aspect of the form here described was said to be scarcely different from that of *M. simonyi*. There are, however, transitional forms of various types, and if the present species is to be retained it becomes necessary to restrict it to only one of these. The most characteristic feature of all these forms of *Monophyllites* is obviously the striation; and in the series from *M. sphærophyllus*, through *M. wengensis*, to *M. simonyi*, there is progressively more pronounced peripheral projection. There are forms intermediate between the former two, including perhaps the examples figured by Salomon (1895, p. 191, pl. vii, figs. 8, 9), Tommasi (1913, p. 68, pl. iv, fig. 27), and Martelli (1904, p. 101, pl. viii, fig. 4; 1906, p. 135, pl. viii, fig. 1), though the last, from the figure alone, cannot be distinguished from *M. sphærophyllus*. Numerous transitions also connect *M. wengensis* and *M. simonyi*, and, as already mentioned, Mojsisovics's large example (fig. 5) belongs to these, besides the Roumanian specimens referred by Simionescu (1913, pp. 332 and 365; pl. vi, figs. 1, 5, 7; pl. vii, fig. 5) to the present species. This author apparently relied for specific separation on the slightly less compressed and less trigonal whorl-section of the majority of his specimens, although the suture-line was said to agree rather with that of *M. simonyi*. But Simionescu, in comparing the radial line of that species with the striæ in *M. wengensis* and *M. aonis*, unfortunately confused these two species; for, as already pointed out, the radial line of *M. wengensis* describes the curve figured by Simionescu in his text-fig. 64A. It is true that in *M. simonyi* the striæ are considerably more sigmoidal and, in addition to the more complex suture-line, the subtrigonal whorl-section is characteristic; but there is scarcely need to create a new name for the intermediate forms. On the other hand, *M. aonis*, as here restricted, having the rib-curve wrongly attributed by Simionescu to *M. wengensis*, obviously is not in the direct line of evolution from *M. sphærophyllus* to *M. simonyi* (since it is later in date than the latter species), but must represent a side branch. There are probably further forms, transitional in other characters, or individual variations; and Kittl (1908, p. 500) has already suggested that one specific name might perhaps be sufficient for all the intermediate forms between the Anisian *M. sphærophyllus* and the Carnian *M. simonyi*.

Renz (1911, p. 58) included the present species in *M. wengensis* as a mutation transitional to *M. simonyi*, and stated that the folds of the inner whorls were less conspicuous in *M. aonis*. Although the peripheral sinus (directed forward) of the striation is not acute enough in the Greek specimens attributed to Klipstein's species, the presence of periodic ridges in *M. wengensis* may be a useful distinguishing feature in immature examples; for the folds previously mentioned as occurring in *M. aonis* are of the type commonly found in *M. sphærophyllus*, and are well depicted in Renz (1911, pl. i, fig. 4).

HORIZON AND LOCALITIES. Lower Carnian, Trachyceratan. Alps; Balkans.

SPECIMENS :

- C. 5579. Feuerkogel, Röthelstein, near Aussee ("Zone of *Lobites ellipticus*")
E. v. Mojsisovics Coll., 1889.

***Monophyllites simonyi* (Hauer).**

Fig. 101, p. 292.

1847, p. 270, pl. ix, figs. 4-6 (*Ammonites*); Diener, 1915a, p. 203;
 Arthaber, 1927, p. 140; Kutassy, 1933, p. 593.

DIAGNOSIS. Subplaty-, subleptogyral, subangustumbilicate *Monophyllites*; whorl-section compressed, subtrigonal, with more narrowly arched venter than other species. Striæ of growth strongly sigmoidal and projected peripherally. Suture-line more advanced than in *M. wengensis* (figs. 100a, p. 286).

MEASUREMENTS :

Mojsisovics, 1873, p. 33	·250	.	·40	.	·24	.	·34
C. 6302a	·245	.	·40	.	·24	.	·33
39877	·162	.	·40	.	·23	.	·33

REMARKS. Renz (1911, p. 68) pointed out that the transverse section of *M. simonyi* was subject to considerable variation, and he recorded, as a variety, a particularly high-whorled compressed form with slightly greater involution. Among the numerous examples in the collection, presumably from at least three zones, individual differences could no doubt be detected by preparation of the suture-lines, or by such misleading plotting of measurements as has lately been suggested for Jurassic *Ammonites* by S. S. Buckman. But, on the whole, the present species is too easily recognizable to admit of doubt in the identifications. Thus the Himalayan examples figured by Diener in 1908 (p. 72, pl. xii, fig. 7) as *M. sp. ind. aff. simonyi*, and in 1909 (p. 14, pl. iv, fig. 3) as *M. cf. simonyi*, although

poorly preserved, may both belong to the present species in spite of obvious differences in the suture-lines. On the other hand, among over 60 specimens of a form apparently transitional between *M. wengensis* and the present species and recorded by Simionescu (1913, p. 365) as *M. aonis*, there was only one in which the ventral area was narrowed and the whorl-section more compressed, so as to suggest reference to *M. simonyi*. It thus seems that there is indeed a continuous series of *Monophyllites* from the base of the Anisian up into the Lower Carnian, but that the assemblage at any given horizon may include forms in which either striation or whorl-shape or else the suture-line are unusually advanced.

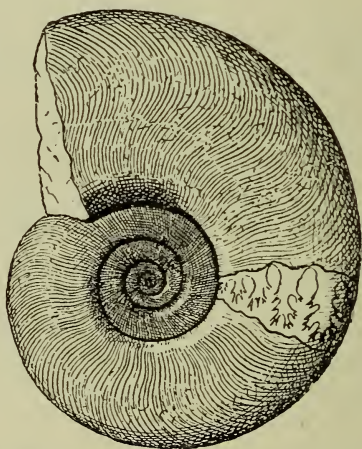


FIG. 101.—*Monophyllites simonyi* (Hauer). Upper Trias, Carnian. Röthelstein, near Aùssee. (After Zittel, 1884, p. 438, fig. 612.)

HORIZON AND LOCALITIES. Lower Carnian ("three sub-zones of *Lobites ellipticus*, *Trachyceras aonoides*, and *Tr. austriacum*" in Renz, 1911, p. 68 = Upper Trachyceratan of Table V, p. 39). Alps; Greece; Roumania; Himalayas; Timor.

SPECIMENS:

C. 6302a-o, 5548a-c, 5557a-c; Raschberg, near Goisern ("aonoides zone"), twenty-one examples.

E. v. Mojsisovics Coll., 1889.

C. 5578a-f, 5580 5583a-c, 5604, 6327a-c, Feurkogel, Röthelstein, near Aussee ("Zone of *Lobites ellipticus*"), fifteen examples.

Same collection.

C. 13620-1. Same locality.

Purchased, 1910.

- 22469a-d. "Hallstatt." *Paul Mohr Coll.*, 1848.
 37175-6. "Near Aussee" and "near Hallstatt".
Tesson Coll., 1857.
 39877. "Salzburg." *Purchased, J. Rothschild, Paris*, 1864.
 74314. "Hallstatt."
John Brown Coll., presented by Prof. Owen, 1860.
 C. 2780. "Hallstatt." *Baber Coll.*, 1889.
 C. 34089-90. Toeboelopo, Timor. *M. E. Walsh Coll.*, 1930.

Genus EOPHYLLITES, Spath.

1930, pp. 85, 89.

GENOTYPE. *Monophyllites dieneri*, Arthaber, 1908, p. 288, pl. xiii, figs. 3a-c.

DIAGNOSIS. More-or-less evolute, discoidal Monophyllitidæ, with arched venter, flattened sides and compressed, subtrigonal whorl-section. More-or-less rectiradiate striæ of growth and indistinct folds. Suture-line with elongated monophyllic saddles, deep first lateral and shallow, wide external lobes.

DISTRIBUTION. Upper Eo-trias, Columbitan?. Albania; Timor.

REMARKS. The type of this genus is not in the direct line of ancestry of *Ussurites* and the more advanced, true *Monophyllites*, since its suture-line differs considerably in several points. *Eophyllites*, however, is associated in the Albanian Lower Trias with several forms referred by Arthaber to species of the Himalayan Anisian, which connect it with such early forms of *Ussurites* as *U. hara* or *U. kingi*, Diener sp. (1895b, pp. 108-109, pl. xxxi, figs. 9a-c, 10a-c, or *U. nov. sp. ind.* (Diener, *ibid.*, fig. 6a, b, and 1915a, p. 207), on the one hand, and with *Leiophyllites* (*Eophyllites variabilis*, nom. nov. = *Monophyllites pitamaha*, Arthaber non Diener) on the other. In the latter case, however, the suture-line is that of *Eophyllites*, and it is to be noted that the only form that shows a suture-line resembling that of *Leiophyllites*, namely *Ussurites* (?) *decipiens*, described below, might be taken for a true *Monophyllites* from its general aspect, but not for a *Leiophyllites*, and was probably correctly referred by Diener (1915a, p. 206) to the genus *Ussurites*.

Whether the unique "*Xenaspis*" *enveris*, Arthaber (1911, p. 230, pl. xx, fig. 3), connects *Eophyllites*, perhaps through "*Xenaspis*" *mediterranea*, Arthaber (1908, p. 261, pl. xi, figs. 3a-c), with such simple Flemingitids as *Dieneroceras*, is as yet uncertain.

***Eophyllites dieneri* (Arthaber).**

1908, p. 288, pl. xiii, figs. 3*a-c* (lectotype); 4*a-c*; 1911, p. 234, pl. xx, figs. 5-8; Diener, 1915*a*, p. 203.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Eophyllites*. Suture-line, etc., as in family diagnosis above.

MEASUREMENTS :

Arthaber, 1908, pl. xiii, fig. 4				
(figure) . . .	50	·41	·24	·31
„ 1911, p. 234 (No. 1) .	46	·41	·22	·35
„ 1911, p. 234 (No. 2) .	48	·44	·25	·35
„ 1908, pl. xiii, fig. 3				
(figure) . . .	63	·43	·27	·30
„ 1911, p. 234 (No. 3) .	64	·44	·27	·33
„ 1911, p. 234 (No. 4) .	94	·43	·23	·30

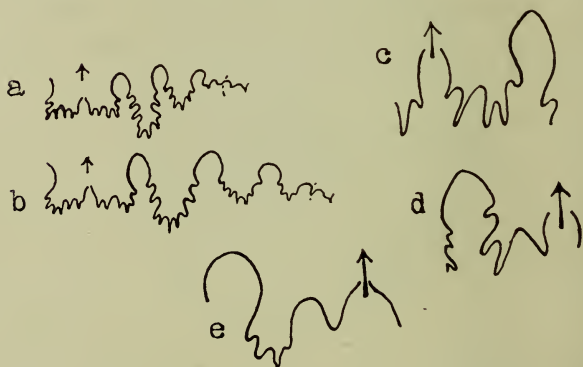


FIG. 102.—Suture-lines of *Eophyllites dieneri* (Arthaber). Upper Eo-trias, Columbitan ?. Albania. (*a, b*, After Arthaber, 1911, pl. xx, figs. 5*c*, 7*c*; *c-e*, from C. 22943, 22947 and 22979, greatly enlarged.)

REMARKS. Arthaber considered his fig. 4 to represent a variety in which the sides were flatter and the umbilical wall higher than in the type, whilst his drawings of the suture-lines also show considerable differences, possibly due partly to the difficulties of preparation. The eleven examples in the Collection, of which six allowed of preparation of the suture-line, again show appreciable differences, especially in the wide external lobes; and three different types are here figured (fig. 102*c-e*). Unfortunately, the abrasion or treatment with acid,

necessary to expose the suture-lines, often destroys the finer details, whilst the generally poor state of preservation of all the Albanian examples prevents separation by means of different dimensions. The form from Timor, described by Welter (1922, p. 118, pl. clxi, figs. 5-7) as *Monophyllites* nov. sp. ind. ex aff. *dieneri*, Arthaber, may owe its peculiar rursicostate striation to deformity; for in those examples of the present species that retain the ornamentation, this is slightly projected across the periphery. Its dimensions, however, are different; its suture-line differs in having simpler lobes, and the second lateral lobe especially ascends towards the umbilicus in the Albanian types; so that we may well distinguish the form from Timor with a new name: *Eophyllites orientalis*, nom. nov.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?. Kçira, Albania.

SPECIMENS :

C. 22939-47, 22948 (a doubtful immature form), 22979.

Baron F. Nopcsa Coll., 1922.

Eophyllites refractus, nom. nov.

Plate III, fig. 4.

1908. *Monophyllites hara*, Arthaber, non Diener, p. 216, pl. xii, fig. 4.

1911. *Monophyllites hara*, Arthaber, non Diener, p. 235.

1915. *Monophyllites (Ussurites) hara*, Diener (a), p. 206.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Eophyllites*. Like *E. dieneri*, but whorl-section with wide ventral area and striæ of growth strongly bent back on peripheral edge. Suture-line with less slender saddles than *E. dieneri* (fig. 102, p. 294).

MEASUREMENTS :

Arthaber, 1908, pl. xii, fig. 4	.	28	·40	·28	·38
C. 22949 (Pl. III, fig. 4)	.	35	·40	·26	·37

REMARKS. The seven paratypes in the collection cannot be satisfactorily distinguished from the inner whorls of *E. dieneri*; and one of the examples of the latter, listed above (C. 22947), still shows the broad venter of the present species at a diameter of over 40 mm., although in suture-line, and especially the slender external saddle, it agrees with the genotype. None of the examples is sufficiently well preserved to show the characteristic ornamentation.

E. nopsai (Arthaber) is more involute, and *Ussurites* (?) *decipiens*, sp. nov., has a more compressed whorl-section and a simpler suture-line than the present species.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?. Kçira, Albania.

SPECIMENS :

C. 22949-51, 22954-55, ? 22952-3.

Baron F. Nopcsa Coll., 1922.

Eophyllites variabilis, nom. nov.

Plate II, fig. 3 ; Plate VI, fig. 1 ; Plate VII, fig. 1.

1911. *Monophyllites pitamaha*, Arthaber, *non* Diener, p. 234, pl. xx, figs. 9-11.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate (var. *involuta*) to latumbilicate (var. *evoluta*) *Eophyllites*. Whorl-section slightly compressed or rounded ; with faint striæ of growth, slightly recurved peripherally, with occasional, indistinct, stronger folds. Suture-line with simpler E than that of *E. dieneri* (fig. 102, p. 294).

MEASUREMENTS :

Pl. VII, fig. 1, C. 22956	.	.	38	·26	?	·50
Pl. VI, fig. 1, C. 22981 (var.						
<i>evoluta</i>)	.	.	21	·24	·24	·52
Arthaber, Pl. XX, fig. 9 (var.						
<i>involuta</i>)	.	.	21	·31	·31	·45
„ „ „ fig. 11 (lecto-						
type)	.	.	37	·27	·24	·48

REMARKS. These dimensions show considerable variation. Among the twenty-seven metatypes in the Collection there are numerous typical examples (*e.g.* C. 22956, here figured, but slightly worn, and C. 22960 and 22967), also the varieties *evoluta* (C. 22981) and *involuta* (C. 22977) ; but, in addition, there are six compressed specimens that may represent the inner whorls of other species, besides a small example (C. 22983, diameter = 14 mm.), in which the folds, about five to the whorl, are unusually strong. Owing to the narrowness of the sides they cause a more tuberculate appearance of these inner whorls than do the longer ribs of young *Monophyllites*, s.s. Whether this stellate example is correctly included in the present species seems doubtful ; but its mode of preservation

(iron-oxide encrustation) and the absence of the suture-line prevent specific separation.

In its general appearance the present form is more like species of *Leiophyllites* than any of the other species of *Eophyllites*. It has already been remarked that, by its suture-line, *E. variabilis* is undoubtedly closer to the genotype, *E. dieneri*, than to the Himalayan *Leiophyllites pitamaha*, Diener sp. (1895*b*, p. 107, pl. xxxi, figs. 7*a-c*, lectotype); but its co-existence with forms like *Ussurites? decipiens* (with the suture-line of *Leiophyllites* and general aspect of *Monophyllites*), indicates that *Eophyllites dieneri* itself is already a specialized form. At present no species of *Eophyllites* is known that could be regarded as in the direct line of ancestry of the later true *Monophyllites* and *Leiophyllites*.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan?. Kçira, Albania.

SPECIMENS:

C. 22956-60, 22962-70, 22973, 22976-78, 22980-1; (?) 22961, 22971-2, 22974-5, 22982-3.

Baron F. Nopcsa Coll., 1922.

Genus PALÆOPHYLLITES, Welter.

1922, p. 118.

GENOTYPE. *Palæophyllites steinmanni*, Welter, 1922, p. 119, pl. clxii, figs. 5-7.

DIAGNOSIS. Evolute Monophyllitidæ, with rounded whorl-section, like *Monophyllites*. Inner whorls smooth, with occasional flares, outer with irregular ribs, slightly projected peripherally. Suture-line simple, with three monophyllic saddles, as in *Leiophyllites*.

DISTRIBUTION. Upper Eo-trias, Prohunganitan. Timor.

REMARKS. This genus is probably allied to the Albanian form described below as *Ussurites? decipiens*, sp. nov. (= *Monophyllites kingi*, Arthaber, non Diener). The four genera, *Eophyllites*, *Ussurites*, *Monophyllites* and *Leiophyllites*, with the present genus, undoubtedly have a common origin, but the Eo-triassic forms are as yet very incompletely known, and, like *Eophyllites dieneri*, the genotype of *Palæophyllites* became too specialized in a definite direction to be considered ancestral to the Anisian genera.

Palæophyllites steinmanni, Welter.

Fig. 103.

1922, p. 119, pl. clxii, figs. 5-7 (lectotype); pl. clxiii, figs. 3-6.

DIAGNOSIS. Subplatygyral, subleptogyral, sublatumbilicate *Palæophyllites*. Whorl-section first depressed and reniform, later (after about 8-10 mm. diameter) circular, and finally compressed (at 25-30 mm.). Inner whorls smooth, with only periodic flares, greatly projected at the umbilical suture, as in Upper Jurassic *Lytoceras*. The flares generally cease at under 20



FIG. 103.—*Palæophyllites steinmanni*, Welter. Upper Eo-trias, Columbitan. Timor. (After Welter, 1922, pl. clxii, figs. 5-7.)

mm. diameter, and give place to obscure ribbing, which may become very pronounced on the body-chamber, especially ventrally. Suture-line, see fig. 103c.

MEASUREMENTS :

Lectotype (fig. 103)	.	.	60	.	.37	.	.25	.	.38
C. 33717	.	.	55	.	.35	.	.28	.	.40

REMARKS. The Collection includes a very fine series of this interesting species, including specimens of all sizes; and although there is some variability, especially in ribbing, they

all clearly belong to the same form. Welter's suggestion, that *Dinarites evolutus*, Waagen (1895, p. 32, pl. x, figs. 3a-c), may possibly be identical with his *Palæophyllites*, is not tenable. The Salt Range species with its compressed whorls is probably a *Xenoceltites* (p. 126), but, as mentioned below, a common origin in a *Dieneroceras*-like form may well account for the external similarity. *Palæophyllites* is the earliest true Monophyllitid, although, on account of its specialized body-chamber, not in the direct line of ancestry of the Middle and Upper Triassic species.

HORIZON AND LOCALITIES. Upper Eo-trias. Timor (*Prohungerites* Bed with manganese-coated fossils).

SPECIMENS :

C. 33717-747. Nifoekoko, Timor.

M. E. Walsh Coll., 1930.

Genus USSURITES, Hyatt.

1900, p. 566.

GENOTYPE. *Monophyllites sichoticus*, Diener, 1895a, p. 29, pl. v, figs. 1a-c.

DIAGNOSIS. Evolute, discoidal Monophyllitidæ, like *Monophyllites* s.s., but with suture-line slightly simpler, external saddle typically indented only on ventral side, and lateral saddles only on dorsal side (fig. 100k, p. 286).

DISTRIBUTION. Lower Middle Trias, Anisian. Siberia ; Spitsbergen ; California ? ; (Japan ?).

REMARKS. Diener (1915c, p. 23) considered that Hyatt, when creating the genus *Ussurites*, was influenced by the absence of a third lateral lobe which is found in the typical *Monophyllites sphærophyllus* (Hauer). This, however, is uncertain. In 1905, Hyatt and Smith described a Nevada form, *Monophyllites billingsianus* (Gabb, p. 94, pl. xxiv, figs. 3, 4), which has a suture-line (fig. 100i, p. 286) almost identical with that of the genotype of *Ussurites*, without even mentioning that genus. Moreover, they erroneously took as genotype of *Monophyllites* Hauer's *Amm. suessi*, which, like *Monophyllites hara* and *M. kingi*, Diener (1895b, pp. 108-9, pl. xxxi, figs. 9, 10), later included by Diener (1915a, pp. 206-7) in *Ussurites*, has only two lateral saddles. Hyatt, of course, may have mistaken *U. sichoticus* for a Lower Triassic species, but it seems to the writer that the present genus may well be restricted to those forms in which the saddles have a tendency to remain entire

on one side, and in which no true third lateral saddle has yet appeared (*U. billingsianus*, Gabb, sp.). *Ussurites* may be made to include both the ribbed Japanese *U. yabei*, Diener sp. (1915c, p. 22, pl. v, figs. 1, 2), and the Himalayan *U. hara*, Diener sp. The former differs from *M. sphærophyllus* merely in slightly less advanced subdivision of L, and the umbilical elements; the latter is in a still more primitive stage, whilst *U. kingi*, Diener, with its very simple suture-line, even resembles *Leiophyllites*. On the other hand, in Nevada, forms of the type of *Monophyllites sphærophyllus* (e.g. J. Perrin Smith, 1914, pl. xxii, figs. 1-5 = *M. billingsianus*, Gabb sp., *partim*) apparently occur together with *Ussurites*, so that that genus is not the ancestor of, but a development parallel with, *Monophyllites* and, like it, originates in *Eophyllites*.

***Ussurites* (?) *spetsbergensis* (Oeberg).**

Plate X, figs. 1-2.

1877, p. 14, pl. iv, figs. 1a, b, non c (*Ceratites*); Mojsisovics, 1886, p. 72, pl. xi, figs. 20, 21; Diener, 1915a, p. 204; Spath, 1921, p. 349 (*Monophyllites*).

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Ussurites*. Whorl-section compressed, with slightly flattened sides and arched venter; striæ of growth as in *M. sphærophyllus*. Suture-line with only two lateral lobes to a considerable diameter (fig. 100h, p. 286).

MEASUREMENTS :

Mojsisovics, 1886, pl. xi, fig. 20	.	95	·39	·30	·32
Pl. X, fig. 2 (C. 37189)	.	45	·42	·34	·31
Pl. X, fig. 1 (C. 37190)	.	40	·43	·34	·35

REMARKS. This species has a slightly simpler suture-line than the forms of *Monophyllites* s.s. here described. In shape it is very similar to the slightly more evolute *M. sphærophyllus*; but the present species may, perhaps, be more appropriately compared to such Himalayan species as *M. hara* and the more compressed *M. kingi*, Diener (1895b, pl. xxxi, figs. 9, 10). The suture-line and whorl shape of the former especially are very similar, but the second lateral saddle is not yet individualized in the Himalayan species. Diener (1915a, pp. 206-7) included these forms in *Ussurites*, but they are undoubtedly also close

to *Monophyllites*, *Leiophyllites* and *Eophyllites*. If the absence of a distinct third lateral lobe be made the reason for separating *Ussurites* from *Monophyllites*, in Diener's sense (1915c, p. 23), the present species, at least in the young, must be referred to *Ussurites*.

HORIZON AND LOCALITIES. Lower Anisian (Middle Trias). Spitsbergen.

SPECIMENS :

C. 26942. Flower Valley, Sassen Bay. (See Spath, 1921, p. 349.)
J. W. Gregory Coll., 1896.

C. 22046. Sassen Bay, Ice Fjord.
W. J. Reynolds Coll., 1920.

C. 37189-90. Sassen Bay, Ice Fjord.
R. G. Segnit Coll., 1921.

***Ussurites arthaberi*, Welter.**

1915. *Monophyllites arthaberi*, Welter, p. 115, pl. lxxxix, figs. 1a-c.

1915. *Monophyllites hara* (non Diener), Welter, p. 115, pl. xc, figs. 1a-c.

1932. *Monophyllites* cf. *arthaberi*, Welter, Wanner, p. 281, pl. xi, figs. 8a-c.

DIAGNOSIS. Subplatygyral, subleptogyral, sublatumbilicate *Ussurites*, with suture-line like that of *U. sichoticus* (see fig. 100k, p. 286), but with less slender whorls and wider umbilicus.

MEASUREMENTS :

Holotype (Welter)	.	.	115	.	·37	.	·33	.	·43
<i>M. hara</i> (Welter non Diener)			83	.	·37	.	·30	.	·41
C. 34088	.	.	153	.	·36	.	·27	.	·47
C. 37212	.	.	40	.	·35	.	·31	.	·42
C. 37213	.	.	45	.	·35	.	·29	.	·44
C. 37214	.	.	47	.	·38	.	·32	.	·43

REMARKS. I agree with Wanner in uniting Welter's two forms, but in the smaller examples from Timor, listed in the above table, the suture-line seems to show the typical *Ussurites* features already at an earlier stage than in Wanner's figured (and rather compressed) specimen. There is some variation in thickness, and the largest example, unfortunately, does not show the inner whorls; but in the smaller specimens the paraboloid ears, described by Welter in both his forms, are generally conspicuous. *Ussurites hara*, Diener sp. (1895b, p. 108, pl. xxxi, fig. 9), has a greater whorl-height and a smaller umbilicus

than the specimens from Timor here listed, and there are also differences in the suture-lines.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Timor. (Reddish-yellow limestones; also pink, manganese-coated matrix.)

SPECIMENS :

C. 34088, 37212-8. Toenioen Eno and Nifoekoko, Timor.

M. E. Walsh Coll., 1930.

Ussurites (?) decipiens, sp. nov.

1911. *Monophyllites kingi*, Arthaber, *non* Diener, p. 235, pl. xx, fig. 12.

1915. *Monophyllites (Ussurites) kingi*, Diener (*a*), p. 207.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate to sublatumbilicate *Ussurites*. Whorl-section compressed, elliptical, with perpendicular umbilical rim; venter arched; with radial striation, with occasional irregular folds. Suture-line simple, with monophyllic saddles, as in *Leiophyllites* (fig. 104, p. 304).

MEASUREMENTS :

Arthaber, 1911, pl. xx, fig. 12	50	·33	·24	·37
C. 22937	50	·44	·26 ?	·32

REMARKS. The only example of this species in the Collection, a metatype of Arthaber's "*Monophyllites kingi*", agrees with his holotype in ornamentation, but does not show the suture-line, and is slightly crushed. If Arthaber's illustration of the lobes (fig. 12c) is reliable, the species is not identical with the Himalayan *Ussurites kingi*, Diener sp. (1895b, p. 109, pl. xxxi, fig. 10), and especially the form from Lilang referred by Diener (1907, p. 105, pl. xiii, figs. 5a, b) to the same species. There may be superficial agreement in dimensions, but the Himalayan form has a rounded umbilical rim, less compressed whorl-section and finer and more regular striation; and its suture-line differs notably in its trifid lobes. The more inflated *U. hara*, Diener sp. (1895b, p. 108, pl. xxxi, figs. 9a-c), with a still more typical *Monophyllites* suture-line (fig. 100j, p. 286), cannot be confused with the present species; but *E. nopcsai* (Arthaber, 1908, p. 287, pl. xii, figs. 5a-c) and the Albanian form wrongly included by Arthaber in the Himalayan species, and described above as *Eophyllites refractus*, sp. nov., are more closely comparable. The latter, however, has a less compressed whorl-section, broader venter and rounded umbilical rim; the former is more involute, with subtrigonal whorl-section; and both have

a more typical *Eophyllites* suture-line, with wide external and almost ammonitic lateral lobes.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?. Kćira, Albania.

SPECIMENS :

C. 22937.

Baron F. Nopcsa Coll., 1922.

Genus **LEIOPHYLLITES**, Diener.

1915a, p. 205 ; 1916, p. 102 ; Arthaber, 1927, p. 138.

GENOTYPE. *Monophyllites suessi*, Mojsisovics, 1882, p. 205, pl. lxxix, fig. 4.

DIAGNOSIS. Evolute, generally smooth, serpenticone Monophyllitidæ with rounded or compressed whorl-section, arched venter and three monophyllic saddles in their simple suture-lines.

DISTRIBUTION. Lower Middle Trias, Anisian. Alps ; Bosnia ; Hungary ; Albania ; Greece ; Roumania ; Anatolia ; Himalayas ; Tonkin ; Japan.

REMARKS. It is possible that the twenty-seven examples above referred to *Eophyllites variabilis* include true *Leiophyllites*, but their unsatisfactory state of preservation prevents preparation of the lobes. The immature example figured in Pl. VI, fig. 1, shows the loose coiling characteristic of the present genus, but the suture-line of the holotype of *Eophyllites variabilis* is far more advanced than it should be in an Eo-triassic precursor of the Anisian group of *L. suessi*. On the other hand, *Ussurites*(?) *decipiens*, with a simple suture-line comparable to that of *Leiophyllites*, may be closer to the unknown *Leiophyllites* ancestor, although it leads to the typical large *Ussurites* and to *Monophyllites* s.s. of higher horizons. *Leiophyllites* is thus not yet definitely recorded from beds earlier than the Anisian, but there are examples of apparently two different species (C. 37283-4) from the *Palæophyllites* Beds of Timor, unfortunately not showing the suture-line, that may be *Leiophyllites*.

Leiophyllites suessi (Mojsisovics).

Fig. 104b.

1882, p. 205, pl. lxxix, fig. 4 (*Monophyllites*) ; Diener, 1915a, p. 206 ; Kraus, 1916, p. 289 ; Kutassy, 1933, p. 595.

DIAGNOSIS. Substenogyral, subleptogyral, latumbilicate *Leiophyllites*.

MEASUREMENTS :

Holotype (Mojsisovics, 1882, p. 205).	37	·27	·22	·51
C. 21042	87	·25	·21	·54

REMARKS. This well-known species differs only slightly in dimensions from *L. taramellii* (Martelli), described below, and *L. confucii*, Diener (1895*b*, p. 107, pl. xxx, fig. 7). The latter was considered by Frech (1911, p. 17, text-fig. 4) to be a variety of the present species, but it has an even wider umbilicus than *L. taramellii*.

If the suture-line of *Leiophyllites* be reduced instead of primitive, it is possible that a form like "*Lecanites*" *sibylinus*, Frech (1911, p. 17, pl. ii, fig. 4), represents a final development of the same stock.



FIG. 104.—Suture-lines of *Leiophyllites*. *a*, *L. taramellii* (Martelli). Anisian. Bosnia. (From specimen C. 21049*b*, enlarged $\times 3$.)
b, *L. suessi* (Mojsisovics). Anisian. Schreyer Alm, Gosau. (After Mojsisovics, 1882, pl. lxxix, fig. 4*c*, reversed.)

It is probable that the present species is represented among a number of *Leiophyllites* from Timor which I take to be (at least partly) forms II and III of Welter's *L. laevis*, discussed below. Their suture-lines (*e. g.*, C. 37285) tend to be slightly simpler than the suture-line of *L. suessi*, agreeing, in fact, with that of *L. indo-australicus*. A new name may be necessary for this form when it is more completely known. Meanwhile the great majority of the examples under discussion may be described as neither so evolute as Welter's form II, nor so involute as his form III, but intermediate between the two. Since, however, many do not show a trace of the suture-line, and since some show a tendency to fastigation of the periphery, it is possible that this assemblage includes even young *Japonites*. In at least one subcarinate form (C. 37286), however, the *Leiophyllites* suture-line is clearly visible.

HORIZON AND LOCALITIES. Lower Middle Trias, Anisian. Alps; Bosnia, Albania; Greece; Roumania; Anatolia; Tonkin.

SPECIMENS :

- C. 5538b.** Schiechlinghöhe, near Hallstatt.
E. v. Mojsisovics Coll., 1889.
- C. 21042.** Stavljan, Volujak Mts., Bosnia.
V. Hawelka Coll., 1906-08.
- C. 21063, 21065.** Suha, on the Sutjeska, Bosnia.
Same Coll., 1907.
- C. 23025.** Albania.
Baron F. Nopcsa Coll., 1922.
- (?) **C. 13079, 14014, 15041.** Dil-Iskelessi, Gulf of Ismid, Asia Minor.
Purchased, 1910, 1911.
 (Three doubtful fragmentary examples comparable to the *L. cf. suessi* figured by Toulà, 1896, p. 171, pl. xx, fig. 7.)
- C. 37285-317, 37340-6.** Nifoekoko, Toeboelopo, etc., Timor.
M. E. Walsh Coll., 1930.
 (These are the doubtful Timor examples discussed above.)

***Leiophyllites taramellii* (Martelli).**

Plate VI, fig. 2.

1906, p. 135, pl. vi, figs. 3, 4.

DIAGNOSIS. Like *L. suessi*, but with wider umbilicus and more rursiradiate striation, occasionally accentuated to form oblique constrictions, scarcely visible on test. Suture-line see fig. 104*a*, p. 304.

MEASUREMENTS :

Holotype (Martelli)	. 69 (28)	. 23	. 17	. 59
C. 20369	. 50	. 24	. 19	. 58

REMARKS. This species lies between the more involute *L. suessi* and the extremely loosely coiled *L. confucii* (Diener, 1895*b*, p. 107, pl. xxx, fig. 7), but the three "species" are very close, and among a number of Bosnian examples of the present form, some might be referred to the compressed and smooth Himalayan type, and others to the more inflated *L. suessi*, which also has similar, if perhaps less pronounced, striation and constrictions.

Monophyllites (*Leiophyllites*) *pradyumna*, Diener (1895*b*, p. 106, pl. xxxi, figs. 3*a-c*, ? 4), is still more inflated than *L. suessi* and has radial ridges. *L. pitamaha*, Diener sp. (1895*b*, p. 107, pl. xxxi, figs. 7*a-c*) is more compressed and more involute than the species here described, but another example figured by Diener (figs. 8*a, b*) has rursiradiate folds or striæ exactly like many of the specimens of *L. taramellii*.

The three Anatolian examples listed above as *L. cf. suessi* (Mojsisovics), Toulas sp., in their greater evolution may be closer to the present species or to *L. confucii* (Diener) than to the common Alpine form, but they are too fragmentary for accurate identification.

HORIZON AND LOCALITIES. Lower Middle Trias, Anisian. Bosnia, Albania.

SPECIMENS :

- C. 20318-21, 20359-60, 20369, 21043-48, 21049a, b, 21050-57**
(and numerous duplicates). Stavljan, Volujak Mts.,
Bosnia. *V. Hawelka Coll.*, 1906-08.
C. 21064. Suha on the Sutjeska, Bosnia. *Same Coll.*
C. 28560-71, 30932-3. Mali-Durmitor Mts., Montenegro.
V. Hawelka Coll., 1926.

***Leiophyllites pradyumna* (Diener).**

1895. *Monophyllites pradyumna*, Diener, p. 106, pl. xxxi, figs. 3a-c.

1915. *Monophyllites (Leiophyllites) pradyumna*, Diener (a), p. 205.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Leiophyllites*, with more distinct striation than other species and conspicuous, parabolar markings, occasionally produced into tubercles and connected with strengthened ribs which, however, do not reach to the umbilicus.

MEASUREMENTS :

Lectotype (Diener's fig. 3)	42	30	24	50
C. 37281	37	32	28	47

REMARKS. The present form is transitional between *Leiophyllites* and other Monophyllitids, and, in its parabolæ, also resembles *Ussurites arthaberi*, but *Monophyllites pseudo-pradyumna*, Welter (1915, p. 117, pl. xc, figs. 4a-c), has a much greater whorl-thickness and a depressed instead of a compressed section. It is perhaps represented by an example in the Collection (C. 37282 from the reddish-yellow limestone of Nifoekoko), which, however, is too small to be definitely identified.

HORIZON AND LOCALITIES. Lower Mesotrias, Anisian (beds with *Sturia mongolica*). Himalayas; Timor.

SPECIMENS :

- C. 37281 (and 37282 ?).** Toeboelopo, Timor.
M. E. Walsh Coll., 1930.

Leiophyllites indo-australicus (Welter).

1915. *Xenaspis indo-austratica*, Welter, p. 129, pl. xciii, figs. 4a-c, 5.

1933. *Xenaspis indo-austratica*, Welter, Kutassy, p. 706.

DIAGNOSIS. Substenogyral, subleptogyral, latumbilicate *Leiophyllites*, with suggestion of blunt ribbing more distinct than in other *Leiophyllites*; but suture-line almost as in *L. taramellii* (see fig. 104a, p. 304), except for the frilling of the umbilical lobe (between the second lateral and internal saddles).

MEASUREMENTS :

Holotype	.	.	.	.	75	.	·27	.	·20	.	·53
C. 37348	.	.	.	.	46	.	·29	.	·21	.	·50

REMARKS. In view of the identity of the suture-line of this species, originally described as "*Xenaspis*", with that of typical *Leiophyllites*, the reference to the present genus is indicated. But if Welter was right in including with this species an example with a whorl-height of 45 mm., then size alone would suggest the creation of a new genus for these forms of "*Xenaspis*" that have almost as much affinity with the Gymnitidæ as with the Monophyllitidæ. Welter compared his species to "*Xenaspis*" *middlemissi*, Diener, here also provisionally referred to *Leiophyllites*, but *Monophyllites pitamaha*, Diener (1895b, p. 107, pl. xxxi, figs. 7a-c, 5 ? and 8 ?), listed by Diener himself (1915a, p. 205) as a *Leiophyllites*, seems to me a much closer ally, although it is more flattened.

Three more doubtful examples with a reddish-yellow matrix have the suture-line of a *Leiophyllites*, and may be transitions between the present species and the more involute *Ussurites* of the *arthaberi* group.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, limestone with *Sturia mongolica*. Timor.

SPECIMENS :

C. 37348-9, 37350-2 ?. Nifoekoko, Toeboelopo, Timor.

M. E. Walsh Coll., 1930.

Leiophyllites lævis (Welter).

1915. *Xenaspis lævis*, Welter, p. 130, pl. xcii, figs. 7a, b only.

1933. *Xenaspis lævis*, Welter, Kutassy, p. 706.

DIAGNOSIS. Like *L. indo-australicus*, but smooth and with flattened whorl-sides and more compressed section.

MEASUREMENTS :

Lectotype (Welter's form I)	. 37	.22	.16	.55
C. 37353	. 18	.23	.20	.60
C. 37354 (transition to <i>L. ? middlemissi</i>)	. 28	.30	.21	.51

REMARKS. Welter pointed out that his species included a number of forms that could be split up into four or five different species; and the examples now included in *L. lævis* are similarly interpreted in a comprehensive manner. Many of them are small, and there seem to be far more specimens of a more involute form, transitional to *L. ? middlemissi*, than there are examples like Welter's fig. 7 (his form I), which must be taken as the lectotype of *L. lævis*. Other specimens again, resembling Welter's fig. 5, but smaller (*e.g.* C. 37235-6), may be merely the inner whorls of *L. pitamaha*, Diener sp. (1895*b*, p. 107, pl. xxxi, figs. 7, 8), but since some of the examples listed below do not show suture-lines, and since there are differences of matrix, it is impossible to identify them with certainty.

Welter's fig. 6 seems to represent quite a different form, perhaps an immature *Monophyllites* or *Ussurites*.

HORIZON AND LOCALITIES. Lower Mesotrias-, Anisian, limestone with *Sturia mongolica*. Timor.

SPECIMENS :

C. 37353-62, ? 37235-7. Toeboelopo, Timor.

M. E. Walsh Coll., 1930.

***Leiophyllites* (?) *middlemissi* (Diener).**

1895. *Xenodiscus middlemissi*, Diener (*b*), p. 110, pl. xxx, fig. 6.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Leiophyllites*, with greater lateral compression of the whorls than other species and somewhat closer coiling. Suture-line as in *L. indo-australicus*.

MEASUREMENTS :

Holotype (Diener)	. . . 55	.33	.15	.44
C. 37238	. . . 57	.33	.16	.42
C. 37239 (transitional)	. . . 54	.34	.23	.44

REMARKS. This species was referred by Diener first to the genus *Xenodiscus* and then (1915*a*, p. 311) to *Xenaspis*, but, like *L. indo-australicus*, it is here taken to be entirely removed from the true Permian *Xenodiscus* and *Xenaspis*, although

similar types, already discussed under *Dieneroceras*, persisted into the Anisian. The only difference between the suture-line of the species here described and that of the typical *Leiophyllites suessi* is in the serration of the lobe across the umbilical suture, but this is accounted for by the increased involution. In Diener's fig. 6c the saddles also appear unusually elongated, but this feature is not seen in the examples from Timor before me.

Many examples have a slightly greater whorl-thickness than the type, such as specimen C. 37239 here listed, and they are probably transitions to *L. indo-australicus*, already described. Others, again, may be intermediate between *L. (?) middlemissi* and *L. pitamaha*, Diener sp., but since they are generally poorly preserved, often in a crystalline matrix, and since the suture-line cannot be exposed, a number of the specimens listed below (possibly even young *Gymnites*) are only provisionally included in the present species.

They comprise a more involute variety (C. 37269) and transitional specimens (C. 37264-8, broken out of the Limestone with *Parasageceras gracile* and *Sturia mongolica*), with suture-lines approaching such more advanced types as *M. kingi* and *M. hara*, Diener (1895b, pl. xxxi, figs. 9c, 10c), also some immature examples (C. 37270-73) and transitions to *L. lævis* (C. 37274-80), in which the lateral flattening of the whorls is more conspicuous than in the type.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Timor.

SPECIMENS :

- C. 37238, 37239, 37241-62, 37264-73, 37275-80. Toeboelopo,
Nifoekoko, Timor. *M. E. Walsh Coll.*, 1930.
C. 37263. Neoetpantokak, Timor. *Same Coll.*
C. 37274. Toenioen Eno, Timor. *Same Coll.*

Genus **MOJSVARITES**, Pompeckj emend.

1895, p. 19 ; Diener, 1915a, p. 206 ; Arthaber, 1927, p. 139.

GENOLECTOTYPE. *Ammonites (Ceratites) agenor*, Münster, 1834, p. 15,
pl. ii, fig. 9.

DIAGNOSIS. Evolute, smooth Monophyllitidæ, with rounded, slightly compressed whorl-section and arched venter. Suture-line monophyllic, with saddles more deeply indented than in *Monophyllites* s.s.

DISTRIBUTION. Upper Trias, Carnian and Norian. Alps ; Hungary ; Himalayas.

REMARKS. Pompeckj, in creating this genus, obviously intended it to include in the first place the Rhaetic *Amm. planorboides*, Gümbel; and he coupled with it the Norian *Monophyllites clio*, Mojsisovics, which had a similar suture-line. The Carnian *M. agenor* and *M. eugyrus* were also included in this genus, but they differ essentially in suture-line; for already in 1873 (p. 34) Mojsisovics had stated that the suture-line of

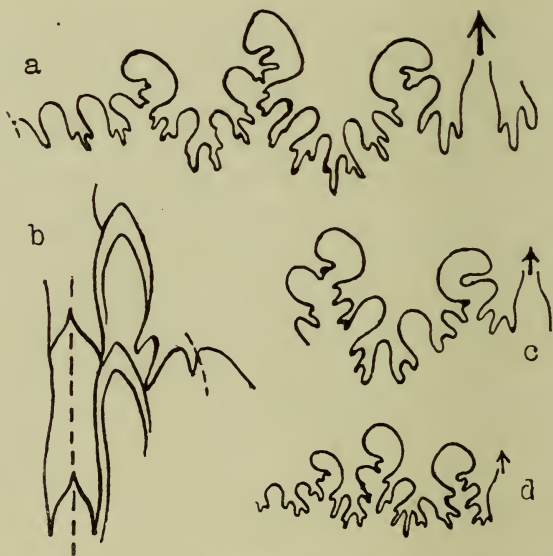


FIG. 105.—Suture-lines of *Mojsvarites*. *a*, *M. eugyrus* (Mojsisovics). From specimen C. 13619, enlarged \times about 2. *b*, Internal lobe of same ($\times 5$). *c*, *M. agenor* (Münster), from specimen C. 27291, enlarged \times about 2. External and first lateral saddles showing similarity to those of *Discophyllites*. *d*, *M. agenor* (Münster). (After Mojsisovics, 1882, pl. lxxviii, fig. 7.) All from Upper Trias, Carnian. .Salzkammergut.

younger examples of his "*Lytoceras*" *eugyrum* showed some similarity to the lobes of "*Lytoceras*" *patens*, inasmuch as the two lateral saddles had almost diphyllic terminations, and that only later the principal leaflet gained in height, giving the suture-line the same aspect as in "*Lytoceras morloti*" (= *Monophyllites agenor*). In the description of *Monophyllites clio* (1893, p. 789), Mojsisovics again stated that a closer relationship to *M. agenor* and *M. eugyrus* was improbable, and that the Norian form would have to be considered to represent an

independent, special series, with the very closely allied "*M.*" *planorboides* (Gümbel) following in higher beds.

In 1902 (p. 316), however, Mojsisovics accepted Pompeckj's *Mojsvarites* as a sub-generic designation for the smooth Monophyllitids, including in it *M. clio*. Only since Diener, in 1915, selected *M. agenor* as type of *Mojsvarites*, it is necessary to give a separate generic name (*Eopsiloceras*, Spath, 1930) to the Norian-Rhaetic stock. This shows specialization of the suture-line in a different direction from that found in the smooth Monophyllitids to which *Mojsvarites* must now remain restricted, however much we may deplore the change of nomenclature.

Mojsvarites agenor (Münster).

Fig. 105c, d.

1834, p. 15, pl. ii, fig. 9, *Ammonites* (*Ceratites*); Diener, 1915a, p. 206; Kutassy, 1933, p. 596.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Mojsvarites*. Whorl-section compressed, elliptical, with high, rounded, umbilical border; sides flattened, with faint sigmoidal striæ of growth or occasional pseudo-constrictions. Suture-line, see fig. 105c.

MEASUREMENTS :

C. 5549a (" <i>Amm. morloti</i> ", Hauer)	70	·41	·30	·31
C. 6303a (" <i>Amm. morloti</i> ", Hauer)	85	·41	·32	·32
Mojsisovics, 1882, pl. lxxviii, figs.				
6a, b	54	·40	·33	·34

REMARKS. This species is distinguished from *M. eugyrus* by its deeper and narrower umbilicus, with conspicuous, high wall. There are, however, transitional forms, and when imperfectly preserved and when the suture-line cannot be exposed, there may be difficulty in correctly identifying these forms. Hauer's *Amm. morloti* (1849, p. 15, pl. ii, figs. 12-14) is now generally considered to be specifically identical with Münster's form, and the writer accepts this identification, although the material at his disposal includes only examples from Hallstatt, in which slight differences from *Mojsvarites agenor* can be noticed in the suture-line. In the case of the Himalayan example figured by Diener (1909, pl. iv, figs. 2a-c), the differences from *M. agenor* may be apparent, owing to a somewhat diagrammatic illustration.

HORIZON AND LOCALITIES. Lower Carnian ("zone of *Trachyceras aonoides*"). Alps; Hungary; Himalayas.

SPECIMENS :

- C. 27291, 27389. "Hallstatt". Paul Mohr Coll., 1848.
 C. 5581, 5582a, b, 5587, 6341, 27287. Feuerkogel, Röthelstein,
 near Aussee. E. v. Mojsisovics Coll., 1889.
 C. 5549a-c, 5558a, b, 6303a-c. Raschberg, near Goisern,
 Austria. E. v. Mojsisovics Coll., 1889.
 C. 1682, 1682a. Hallstatt. J. E. Lee Coll., 1885.

Mojsvarites eugyrus (Mojsisovics).

Fig. 105a, b, p. 310.

1873, p. 34, pl. xix, figs. 12, 13 (*Lytoceras*); Diener, 1915a, p. 206.

DIAGNOSIS. Like *M. agenor*, but more evolute, with shallower umbilicus and slightly more complex suture-line (figs. 105a, b).

MEASUREMENTS :

Mojsisovics, 1873, holotype	.	99.5	.30	.24	.38
„ 1900, p. 114, pl. xix,					
fig. 7 . . .	.	13	.34	.27	.45
C. 13619 (topotype)	.	84	.35	.31	.40

REMARKS. The examples in the Collection, including the topotype of which measurements and suture-line are here given (fig. 105a, p. 310), are not so compressed as Mojsisovics's original, and the umbilical rim is steeper. They agree, however, in the open umbilicus, and especially in suture-line, and in view of our separation of *Mojsvarites* from *Eopsiloceras*, it is important to note that the evolution of the suture-line tends in the direction of *Discophyllites*, with the unequally bifid termination of the lateral saddles already very neatly indicated. The present species is not, therefore, directly related to "*Monophyllites*" *clio*, Mojsisovics, as Pompeckj held, but, with *Mojsvarites agenor*, it belongs to a lineage derived independently from a more primitive *Ussurites*-like type, and intermediate between *Monophyllites* and the genus *Discophyllites*, Hyatt.

Mojsvarites laubei (Gemmellaro, 1904, p. 295, pl. xxvii, figs. 1-3) and *M. jacquoti* (Gemmellaro, *ibid.*, figs. 4-6) are more involute than the present species, and the latter especially is also more compressed.

HORIZON AND LOCALITIES. Lower Neo-trias, Carnian. Alps; Himalayas.

SPECIMENS :

- C. 13619. Röthelstein, near Aussee. *Purchased* 1910.
 C. 6340a, b. Same locality (Feuerkogel).
E. v. Mojsisovics Coll., 1889.
 C. 27292. Raschberg, near Goisern.
Same Coll. (transitional to *M. agenor*, Mojsisovics sp.).

Genus **EOPSILOCERAS**, Spath.

1930, p. 9 (*Mojsvarites*, auct., *partim*).

GENOTYPE. *Ammonites planorboides*, Gümbel, 1861, p. 410; Pompeckj, 1895, pl. i, fig. 1.

DIAGNOSIS. More-or-less evolute, smooth, discoidal Monophyllitidæ with compressed-elliptical whorl-section and narrowly arched venter. Suture-line with more or less symmetrical saddles bearing monophyllic terminal leaflets and smaller phylloid lateral leaflets; auxiliaries inverse.

DISTRIBUTION. Norian and Rhaetic. Alps.

REMARKS. The reasons for the separation of *Eopsiloceras* from *Mojsvarites*, necessitated by Diener's selection of *M. agenor* as the genolectotype, have already been given (p. 311). On a previous occasion (Spath, 1914, p. 351), when comparing the monophyllic terminal leaflet, so conspicuous in the suture-development of *Tragophylloceras loscombi*, to that found in the saddles of *E. clio* and *E. planorboides*, I mentioned that *Psiloceras*, with its dependent auxiliaries, was not the descendant of *E. clio* or of *E. planorboides*, as Mojsisovics (1893, p. 789) and E. Haug (1907, p. 950) seemed to think; for this genus ("*Mojsvarites*") had attained already a fairly involute condition in the Rhaetic, whereas *Psiloceras* (and especially *Parapsiloceras*, which resembled so closely the primitive *Pleuracanthites polycycloides*, Wähner) was still latumbilicate. *Psiloceras* was, therefore, considered to be neither a derivative of the diphyllic Discophyllitids, nor of *Phylloceras*, as Pompeckj (1895, p. 40) thought; but to have come from a branch of the original *Monophyllites* root-stock, that might have given rise to *Mojsvarites* as well, although it persisted itself in a less advanced condition through Rhaetic times.

The folds appearing first on the inner whorls of certain *Psiloceratids* are probably cænogenetic. Instead of calling *Psiloceras* a "degenerate (smooth) derivative of a *Caloceras* stock" (S. S. Buckman, 1912, p. vii), the writer would look

upon *Caloceras* as a later development of the smooth Psiloceratidæ, with costation retained to the end. It will be remembered that in Schlotheimidæ the family characteristic (ventral groove) similarly first appears on the inner whorls of *Wæhneroceras* of the *extracostatum* group, becomes more pronounced on the inner whorls of the groups of *Saxoceras iapetus* (Spath) and *S. prometheus* (Reynès), and persists to the outermost whorls only in the late group of *Scammoceras angulatum* (Spath, 1924, p. 198 ; 1925, p. 201 ; Salfeld, 1924, p. 7).

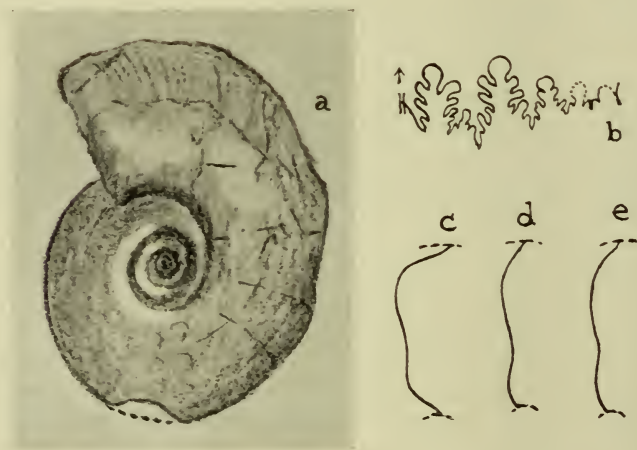


FIG. 106.—a, b, e, *Eopsiloceras planorboides* (Gümbel). Rhaetic. Bavarian Alps. Side view of crushed example, suture-line and course of striation. c, d, Radial lines of *Monophyllites simonyi* and of *Mojsvarites agenor* for comparison. (After Pompeckj, 1895, pl. i, fig. 1, text-figs. 2, 3, p. 19.)

Eopsiloceras planorboides (Gümbel).

1861, p. 410 ; Diener, 1915a, p. 206.

DIAGNOSIS. Subplatygyral, compressed, subangustumbilicate *Eopsiloceras*. Faint biconcave striæ of growth, with slight peripheral projection. Suture-line as for the genus.

MEASUREMENTS :

Pompeckj, 1895, pl. i, fig. 1	.	50	·38	?	·32
C, 12293	{ (at)	40	·38	?	·30
		55	·38	?	·33

REMARKS. This species is known only in crushed specimens, so that the whorl-thickness cannot be determined. *Eopsiloceras clio* (Mojsisovics) is more evolute, and has narrower and rounder whorls. In the absence of the suture-line distinction from similarly crushed involute *Psiloceras* or *Paradasyceras* is impossible.

HORIZON AND LOCALITIES. Upper Rhaetic, Kössen Beds. Alps.

SPECIMENS :

C. 12292-5. Lahnewiesgraben, near Garmisch, Bavaria.

Exchange Munich Museum, 1909 (Impressions of six individuals).

B. Family DISCOPHYLLITIDÆ, Spath.

Spath, 1927, p. 37 (as sub-family).

DIAGNOSIS. Discoidal, more-or-less evolute, smooth and round-ventered ammonites, like Monophyllitidæ, but with principal saddles having di- or triphyllitic terminations.

REMARKS. All authors are agreed that this sub-family includes the ancestors of the Jurassic and Cretaceous Phylloceratids, but there is as yet no form known from the Rhaetic that connects Discophyllitinæ with either Rhacophyllitinæ or Phylloceratinæ s.s. as neatly as *Eopsiloceras* connects *Mojsvarites*, and the Monophyllitidæ with the Lower Liassic Psiloceratidæ. The true *Discophyllites* (*patens* group only), as Mojsisovics and Pompeckj (1895, p. 39) already suggested, probably is transitional from *Mojsvarites*; in the other genera of the present family the subdivision of the saddles becomes more typically rhacophyllitid. There can be no doubt, however, that the separation of all post-Triassic Phylloceratids into descendants of *Diphyllites* (*neojurensis* group) and "*Triphyllites*" (*debilis* group), as suggested by Jullien (1911, p. 129), is not possible in the present state of our knowledge. Jullien's scheme, of course, suffers in the first place from his considering a number of forms, that may not even belong to the same horizon, to represent the males and females respectively. Kilian (1915, p. 332) has already pointed out that the vertical and horizontal distribution of Jullien's various species did not support his contention, and the divisions, *Diphyllites* and *Triphyllites*, cannot be accepted for post-Triassic forms, although the former, the genotype of which is *Ammonites neojurensis*, Quenstedt, must be adopted for those Rhacophyllitids that

are distinguished from *Discophyllites* by their diphyllic external saddles. The beautifully preserved Timor material has demonstrated that, even for the Triassic forms, the separation of "*Triphyllites*" from *Diphyllites* is impossible, either on the basis of the more-or-less unsymmetrically subdivided first lateral saddle or the variable median saddle in E.

Tragorhacoceras occultum (Mojsisovics) was already considered by its author and by Diener to be rather distinct from the rest of the Triassic Phylloceratids, and, like the restricted Liassic *Rhacophyllites*, it is characterized by a modified body-chamber.

The Lower Liassic *Paradasyceras*, Spath, including the well-known "*Rhacophyllites*" *stella* (J. de C. Sowerby) with its offshoot *Schistophylloceras*, Hyatt, together with *Geyeroceras*, Hyatt, are probably direct descendants of the *Discophyllitinae*, but have been grouped by the writer in a sub-family *Rhacophyllitinae*. The true *Phylloceras* s.s., with closed umbilicus, does not seem to have yet been found in the lowest Liassic strata, but Arthaber has lately (1927) described some involute *Diphyllites* from Timor. On the other hand, the *Calliphylloceratinae*, or at least *C. capitanei* (Catullo), had already been traced back to the Hettangian "*Phylloceras*" *togatum*, Neumayr, by Prinz (1905, p. 54), but this constricted form cannot yet be attached to any member of the *Discophyllitinae*. *Diphyllites vredenburgi* (Diener, 1906, p. 18, pl. iv, fig. 2), of the Baluchistan Norian, also already has the whorl-shape of *Geyeroceras*.

Genus DISCOPHYLLITES, Hyatt.

1900, p. 566 ; Diener, 1915*a*, p. 219 ; 1919, p. 41 ; J. P. Smith, 1927, p. 99.

GENOTYPE. *Lytoceras patens*, Mojsisovics, 1873, p. 34, pl. xvi, fig. 13 ; pl. xix, fig. 17.

DIAGNOSIS. As for sub-family. Suture-line with external saddle unsymmetrically monophyllic.

DISTRIBUTION. Upper Trias, Carnian and Norian (passage beds). Alps ; Sicily ; Himalayas ; Timor ; California ; Alaska.

REMARKS. Diener's (1919) interpretation is here accepted. The form from Timor described by Welter as *Discophyllites* cf. *ebneri*, is now specifically united with Mojsisovics's Himalayan type, and the few species listed by Diener and Kutassy (1933, p. 650) are extremely closely allied.

Discophyllites patens (Mojsisovics).

1873, p. 34, pl. xvi, fig. 13; pl. xix, fig. 17 (*Lytoceras*); Diener, 1919, p. 381, text-figs. 15, 16; 1925, p. 74, pl. xx, fig. 5 (*Discophyllites*); J. P. Smith, 1927, p. 100, pl. lxii, figs. 1-13; pl. ciii, figs. 4-6 (*Rhacophyllites* [*Discophyllites*]).

DIAGNOSIS. Subplatygyral, subleptogyral, sublatumbilicate *Discophyllites*. Whorl-section elliptical, with arched venter and high, but rounded, umbilical wall. With very faint striæ of growth, slightly projected peripherally. Suture-line with external saddle comparatively simple.

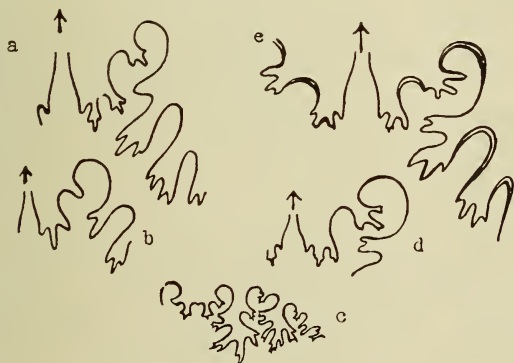


FIG. 107.—*a, b*, *Discophyllites patens* (Mojsisovics). Upper Trias. Hallstatt. External saddles of two examples (C. 12836 and 27286) at diameters of 55 and 15 mm. respectively (enlarged). *c*, External suture-line, showing high ventral lobe. (After Mojsisovics, 1873, pl. xix, fig. 17.) *d, e*, *D. ebneri* (Mojsisovics). Timor. From example C. 21782, at diameters of 40 and 100 mm. (For internal lobe, see fig. 108*b*.)

MEASUREMENTS :

Diener, 1919, No. II .	137	·40	·28	·35
„ „ „ III .	246	·41	·27	·35

REMARKS. Diener has pointed out that this species differs from the Sicilian *D. insignis*, Gemmellaro sp. (1904, p. 298, pl. i, figs. 21, 22; pl. ix, figs. 13-16), in its less cordiform whorl-section, whilst the Himalayan *D. ebneri*, Mojsisovics sp. (1896, p. 668, pl. xix, fig. 6, and 1899, p. 116, pl. xix, fig. 6), also has a slightly less elliptical whorl-section and perhaps a more distinctly diphyllic second lateral lobe. The external saddle is also more deeply divided in *D. ebneri* (see figs. 107, 108), but

there is considerable variation. Prof. J. P. Smith considered the three "species" to be identical.

The transitional nature of certain *Mojsovites*, clearly recognized already by Mojsisovics, is apparent on comparison of figs. 105 and 107. The external saddle of an immature *Discophyllites patens* (fig. 107b) is indistinguishable from that of similar young *Mojsovites eugyrus* (fig. 105a) or *M. aff. agenor* (fig. 105c); but the lateral saddle in *Discophyllites* is already more distinctly bifid at an early stage.

HORIZON AND LOCALITIES. Upper Trias, Norian. Alps; Alaska.

SPECIMENS :

C. 5586, 27285-6, 27288 ? 27289 ? Feuerkogel, Röthelstein, near Aussee, Austria (zone of *Lobites ellipticus*).

E. v. Mojsisovics Coll., 1889.

C. 12836. Someraukogel, Hallstatt, Austria. Purchased 1910.



FIG. 108.—*Discophyllites ebneri* (Mojsisovics). Upper Trias.
a, External suture-line, after Welter, 1914, fig. 74, p. 203.
b, Internal suture-line from example C. 21782, at diameter = 100 mm.

Discophyllites ebneri (Mojsisovics).

1896, p. 668, pl. xix, fig. 6, and 1899, p. 116, pl. xix, fig. 6; Diener, 1915a, p. 219; 1919, p. 382.

DIAGNOSIS. Like *D. patens*, but with a whorl-section with greatest thickness closer to umbilical border.

MEASUREMENTS :

Welter (1914, p. 204)	.	108	.	.42	.	.27	.	.34
C. 21782	.	(at) 75	.	.40	.	.30	.	.36
"	.	(at) 120	.	.41	.	.30	.	.34
C. 21793	.	210	.	.42	.	.29	.	.34

REMARKS. This species is intermediate in whorl-section

between the more regularly elliptical *D. patens* and the cordiform *D. insignis*. Since the Himalayan type is fragmentary, its identification with the plentiful and beautifully preserved specimens from Timor may, perhaps, be open to doubt: the slight differences in the suture-lines, especially the second lateral lobes, are found to be too inconstant to justify specific separation.

The New Zealand example figured by C. T. Trechmann (1918, p. 184, pl. xvii, fig. 7) as *Discophyllites* cf. *ebneri*, like Diener's "*D. ebneri*" from the *Tropites* Limestone of Byans (1906, p. 137, pl. v, fig. 5), does not belong to the present genus.

HORIZON AND LOCALITIES. Upper Trias, Upper Carnian ?. Himalayas; Timor; Alps.

SPECIMENS. :

C. 21782, 21785, 21793. Nifoekoko, near Niki-Niki, Timor.

Geol. Inst. Bonn, 1920.

C. 34078-86, 34101. Toeboelopo, Timor.

M. E. Walsh Coll., 1930.

Genus **DIPHYLLITES**, Jullien.

1911, p. 129.

GENOTYPE. *Ammonites neojurensis*, Quenstedt (in Hauer, 1846, p. 8, pl. iii, figs. 2-4).

DIAGNOSIS. Discophyllitidæ with suture-line having the external saddles diphyllic and the two lateral saddles diphyllic or triphyllic. (See also remarks under family.)

DISTRIBUTION. Upper Trias, Carnian and Norian. Alps; Hungary; Sicily; Himalayas; Timor.

REMARKS. It has already been mentioned that the separation of "*Triphyllites*", Jullien (for the group of *Ammonites debilis*, Hauer), from the present genus is impracticable, and it need only be recalled that Quenstedt originally considered the differences between *Amm. neojurensis* and *Amm. debilis* to be too minute to regard the latter as even a variety of the former. The dozen or so of species now recognized in this group are all connected by transitional forms.

Diphyllites neojurensis (Quenstedt).

Plate IV, figs. 3a, b.

1845, p. 682; Hauer, 1846, p. 8, pl. iii, figs. 2-4 (*Ammonites*); Diener, 1915a, p. 220 (*Phylloceras*); 1919, p. 378, text-fig. 14; 1925, p. 74, pl. xx, figs. 6a-c; Kutassy, 1933; p. 649 (*Rhacophyllites*).

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Diphyllites*. Whorl-section elliptical, slightly compressed, venter arched; with very faint, sigmoidal striae of growth. Suture-line with more or less symmetrically diphyllic principal saddles and deep L.

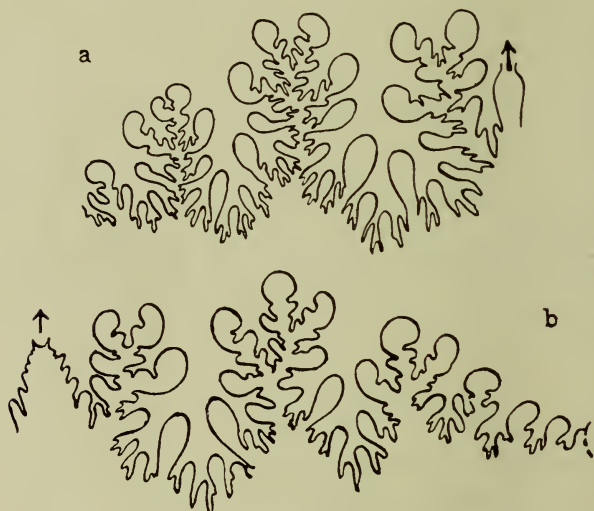


FIG. 109.—*a*, *Diphyllites neojurensis* (Quenstedt). Upper Trias, Norian. Hallstatt. (After Hauer, 1846, pl. iii, fig. 4.) *b*, *D. debilis* (Hauer). Same horizon and locality. (*Ibid.*, pl. iv, fig. 3, reduced to $\frac{3}{4}$ linear.)

MEASUREMENTS :

Mojsisovics, 1873, p. 38, I	74	.	.47	.	.40	.	.23
„ „ „ II	29	.	.43	.	.40	.	.30
C. 13642	100	.	.48	.	.40	.	.36
C. 29325	85	.	.46	.	.40	.	.26
Welter (1914, p. 200)	77	.	.46	.	.40	.	.30
? Diener, 1919, p. 39, No. I	54	.	.45	.	.35	.	.26
? „ „ „ No. II	177	.	.44	.	.33	.	.28

REMARKS. Welter (1914, p. 199) and Diener (1919, p. 380) have drawn attention to the great variability in whorl-section, and even in suture-line, shown by certain specimens referred to this form; but it seems that typical examples of Quenstedt's megalomorph species, as Mojsisovics pointed out, can, indeed, be easily identified by their comparatively inflated whorl-section. To judge by specimens in the Collection from the Feuerkogel,

the two examples recorded by Diener (of which the measurements are here listed), may more correctly be referable to the species described below. The compressed inner whorls of the examples from Timor, listed below, also make it probable that they are really transitional forms to such species as *D. floweri* and *D. zitteli*, and not identical with the typical *D. neojurensis* from the Red Marble of the Someraukogel near Hallstatt. In the case of immature examples exact identification is difficult,

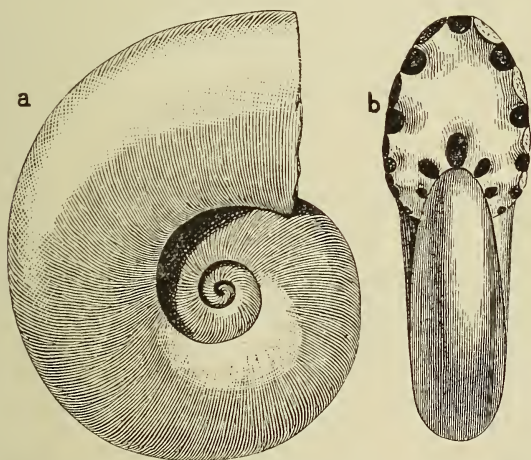


FIG. 110.—*Diphyllites neojurensis* (Quenstedt). Upper Trias, Norian. Hallstatt. (After Zittel, 1884, p. 439, fig. 613.)

but Mojsisovics's smaller example already shows at only 29 mm. diameter the typical whorl-thickness of 40% of the diameter. On the other hand, a specimen in the Collection (C. 13644, labelled "*Rhacophyllites despectus*", Mojsisovics, but with the complex suture-line of the present species) has a whorl-thickness (and height) of 46% at a diameter of 35 mm., and thus represents a still more inflated type.

HORIZON AND LOCALITIES. Upper Trias, Norian. Alps; Timor.

SPECIMENS :

C. 541. Hallstatt, Austria.

R. Damon, 1884.

A gigantic example of 350 mm. diameter, bearing Haidinger's original label : "*Ammonites neojurensis*, Quenstedt. K.K. Geol. Reichsanstalt, 20. April 1861."

22470. Hallstatt. *P. Mohr Coll.*, 1848.
 C. 27356. "Hallstatt." *J. Baber Coll.*, 1889.
 C. 1678. "Hallstatt." *J. E. Lee Coll.*, 1885.
 C. 1679. Watzmann, Bavaria. *Same Coll.*
 C. 1686-7. Raschberg, near Goisern, Austria. *Same Coll.*
 C. 13642, 13644. Someraukogel, Hallstatt. *Purchased*, 1910.
 C. 5713a-j, 5731, 6297, 27325, 27358, 27361. Someraukogel,
 Hallstatt. *E. v. Mojsisovics Coll.*, 1889.
 C. 21783, 21784. Bihati, Baung, Amarassi, Timor.
J. Wanner Coll. Geol. Pal. Inst. Univ. Bonn, 1920
 (Pl. IV, fig. 3).
 C. 34094-104. Toeboelopo, Timor. *M. E. Walsh Coll.*, 1930.

Diphyllites zitteli (Mojsisovics).

1902, p. 318, pl. xvii, figs. 3, 4 (*Rhacophyllites*).

DIAGNOSIS. Like *D. neojurensis*, but more compressed, smaller and with less indented suture-line. Three principal saddles diphyllic.

MEASUREMENTS :

Mojsisovics, p. 318 .	45	.	44	.	34	.	30
C. 13645 .	38	.	45	.	36	.	30
C. 5584 .	60 (50)	.	44	.	35	.	30

REMARKS. This rare species was described as the earliest form of its genus, and as being close to the micromorph *D. pumilus* (Mojsisovics, 1873, p. 40, pl. xvi, figs. 8 and 12) of the next higher set of beds. The latter differs from it merely in its proportions and in its lower external lobe. *D. floweri* (Diener, 1908, p. 23, pl. viii, fig. 2; pl. ix, fig. 2) was stated by its author to differ from the present species in the smaller size of the monophyllic auxiliary saddle—obviously an unimportant character, if indeed the small appearance of the saddle was not due entirely to the difficulty of representation in a small drawing. The proportions of the two examples recorded by Diener (76-48-33-32 and 52-46-34-32) are close enough to those of the species here discussed.

D. joharensis (Diener, 1915a, p. 219 = *Discophyllites ebneri*, Diener, non Mojsisovics, 1906, p. 173, pl. v, fig. 5), with its curiously subdivided lateral saddles, appears to be entirely distinct from *D. zitteli*, although somewhat similar in its compressed whorls.

The New Zealand form of *Diphyllites*, described by C. T. Trechmann (1918, p. 184, pl. xvii, fig. 7) as *Discophyllites* cf. *ebneri*, may belong to the present species, but is still septate at 240 mm. Its whorl-height of 43% and umbilicus of 31% of the diameter agree well enough with *D. zitteli*, but it is probably crushed, and the crushing gives an extremely compressed whorl-section.

HORIZON AND LOCALITIES. Upper Trias, Carnian. Alps.

SPECIMENS :

C. 5584. Feuerkogel, Röthelstein, nr. Aussee, Austria.

E. v. Mojsisovics Coll., 1889.

C. 13645. Same locality.

Purchased, 1910.

Diphyllites debilis (Hauer).

1846, p. 10, pl. iv, figs. 1-3 (*Ammonites*); Diener, 1915a, p. 219; Kutassy, 1933, p. 648 (*Rhacophyllites*).

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Diphyllites*. With more compressed whorls than *D. neo-jurensis*, with narrower venter and asymmetrically subdivided lateral saddles (fig. 109b, p. 320).

MEASUREMENTS :

Mojsisovics, 1902, p. 319 . 102 . .42 . .30 . .29

C. 5736a 80 . .44 . .32 . .29

C. 27290 67 . .42 . .32 . .30

REMARKS. This easily-recognized species is well represented in the Collection. The differences from the inflated *D. neo-jurensis* have been discussed by Mojsisovics (1902, p. 319), and the asymmetrical development of the lateral saddles in the present form also prevents confusion with *D. zitteli*.

The form from Timor, described by Welter as *Discophyllites debilis timorensis* (Welter, 1914, p. 204, pl. xxx, figs. 12, 13), known to him in only one example, with dimensions 88-45-36-32, does not appear to be specifically separable from *D. debilis*. It is represented in the collection by three specimens.

HORIZON AND LOCALITIES. Upper Trias, Norian. Alps; Timor.

SPECIMENS :

62484. Hallstatt.

Dr. Bruckmann Coll., 1858.

C. 1681 (Sandling), 27305 (Hallstatt), 27464, 27357 (Raschberg, nr. Goisern).

J. E. Lee Coll., 1885.

C. 27290, 27461-3. Hallstatt.

P. Mohr Coll., 1848.

- C. 31878. Hallstatt. *Purchased*, 1928.
 C. 13641, 13643. Someraukogel, Hallstatt. *Purchased*, 1910.
 C. 5737a-g, 5736a-k, 6280, 27362, 27465. Leisling, nr. Goisern.
E. v. Mojsisovics Coll., 1889.
 C. 5714a-j. Someraukogel, Hallstatt. *Same Coll.*
 C. 34091. Nifoekoko, Timor. *M. E. Walsh Coll.*, 1930.
 C. 34092-3. Toeboelopo, Timor. *M. E. Walsh Coll.*, 1930.

Genus **TRAGORHACOCERAS**, Spath.

1927 (Kachh Revision, Pal. Indica), p. 37.

GENOTYPE. *Phylloceras occultum*, Mojsisovics, 1873, p. 38, pl. xvi, figs. 3-6.

DIAGNOSIS. Discophyllitids, with plumper (diphyllic) saddles than *Diphyllites neojurensis*, but more numerous auxiliaries, and ornamentation on the larger whorls, as in *Rhacophyllites*.

DISTRIBUTION. Upper Trias, Norian. Alps; Sicily.

REMARKS. The characteristic suture-line in this stock remains in the stage already attained by *Diphyllites* in the Carnian. The very simple diphyllic saddles, with large terminal leaflets, are quite distinct from those of *Diphyllites*. The appearance of ribs (at first fasciated, biconvex striæ), most strongly developed on the ventral area, is well shown in the Sicilian *T. billiense* (Gemmellaro, 1904, p. 294, pl. xxiii, fig. 6).

Tragorhacoceras occultum (Mojsisovics).

1873, p. 38, pl. xvi, figs. 3-6; Diener, 1915a, p. 220; Arthaber, 1927, p. 140.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Tragorhacoceras*. Whorl-section elliptical, slightly compressed, venter arched. Smooth in young; body-chamber with peripheral ridges. Suture-line with large terminal leaflets (and smaller ones below) on three, very simple, bifid, principal saddles. Four monophyllic auxiliary saddles.

MEASUREMENTS :

Mojsisovics, 1873, p. 38	.	60	.	43	.	37	.	25
C. 27359	.	.	.	60	.	45	.	35
	.	.	.	.	.	35	.	23

REMARKS. This species is poorly represented in the Collection. Even after grinding down the corroded surfaces and attempting to expose the suture-lines by means of acid, it is often impossible

to separate specifically the more crystalline of these marmorized Discophyllitids. *Diphyllites debilis*, especially, differs from *Tragorhacoceras occultum* only in slightly greater compression, whilst *D. neojurensis* is more inflated; when the suture-line is exposed, there is no difficulty, of course, in recognizing the present species. The example here listed is still septate at a

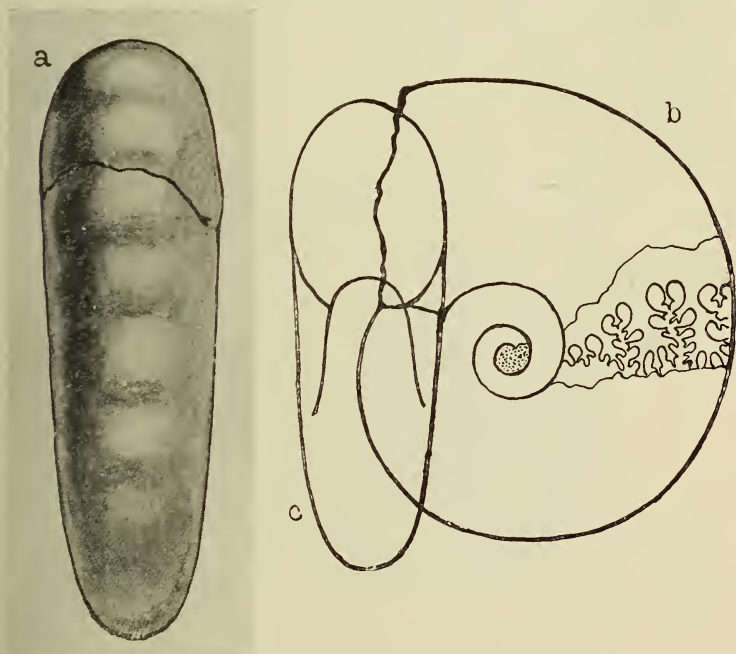


FIG. 111.—*Tragorhacoceras occultum* (Mojsisovics). Upper Trias, Norian. Sandling. *a*, Peripheral view of body-chamber. *b*, *c*, Diagrammatic side-view and sectional outline, with part of suture-line. (After Mojsisovics, 1873, pl. xvi, figs. 4, 5*a*, *b*.)

diameter of 60 mm., but already shows indistinct peripheral ridges on the last quarter of a whorl. Although its suture-line has the unmistakable terminal leaflets of *Tragorhacoceras*, its whorl-section is more like that of *Diphyllites debilis* than that of Mojsisovics's holotype here refigured (fig. 111*a*).

HORIZON AND LOCALITY. Upper Trias, Norian. Hallstatt.

SPECIMENS :

C. 27359. Leisling, near Goisern. *E. v. Mojsisovics Coll.*, 1889.

Genus **TRACHYPHYLLITES**, Arthaber.

1927, p. 141 (as sub-genus of *Monophyllites*).

GENOTYPE. *Trachyphyllites costatus*, Arthaber, 1927, p. 141, pl. xvii, fig. 3.

DIAGNOSIS. Loosely coiled, rounded-whorled Discophyllitids, with sigmoidal striæ of growth; about six of these on each whorl thickened into ribs or flares. Suture-line with subdivided saddles, less "rhacophyllitic" than in the other genera of the family.



FIG. 112.—*Trachyphyllites costatus*, Arthaber. Norian. Timor.
(After Arthaber, 1927, pl. xvii, figs. 3a-c.)

DISTRIBUTION. Neo-trias, Lower or Middle Norian?. Timor.

REMARKS. On account of its complex suture-line with subdivided saddles, *Trachyphyllites* must be excluded from the Monophyllitidæ, in spite of superficial resemblance to *Monophyllites pradyumna*, Diener (1895b, pl. xxxi, fig. 3). The unique and fragmentary holotype is badly preserved, but it appears to be an important link between the Monophyllitids and Discophyllitids, retaining the whorl-shape of the former, but acquiring an ammonitic suture-line. Its resemblance to certain Lower Liassic "Pleuracanthitids" (Spath, 1924, p. 189) and Lytoceratids is also significant.

V. Super-family CERATITIDA, Hyatt emend.

1900, p. 557.

DIAGNOSIS. Typically highly ornamented or tuberculate descendants of Meekoceratida, with ceratitic suture-lines that may become either reduced or complicated in special offshoots, some of which may also be secondarily smooth.

OBSERVATIONS. It has already been mentioned that in the case of some transitional groups like the Dinaritids, the inclusion in Ceratitida instead of the Meekoceratida may be open to criticism, but it is prompted by their obvious affinity with the far commoner Tirolitids. The Hungaritidæ are less easy to place. They are a polyphyletic assemblage of keeled derivatives of Meekoceratids as well as Ceratitids, and they are here retained as one unit only because the few Eo-triassic members (*Dalmatites*, Kittl; *Arctohungarites*, Diener; **Prohungarites**, gen. nov. [for *P. similis* nov. = *Hungarites* cf. *middlemissi*, Welter, non Diener]; *Pseudharpoceras*, Waagen) are as yet too incompletely known to allow of a satisfactory subdivision.

A. Family PRIONITIDÆ, Hyatt emend.

1900, p. 556.

DIAGNOSIS. Ribbed and tuberculate Ceratitida, being developments of Meekoceratidæ, with the tendency to acquire a broadly tabulate periphery, without the transverse costæ or notches of Sibiritidæ. Suture-line as in *Meekoceras*, with serrated auxiliary series.

REMARKS. Of Hyatt's original Prionitidæ only the type genus *Prionites*, Waagen, and "*Goniodiscus*" are now left in this family. It also includes the Arctic "*Prionites*", one species of which shows a curious resemblance both to *Hemi-prionites*, Spath (p. 330), proposed for "*Goniodiscus*", Waagen (which is preoccupied), and to a form (No. 9) included by Welter in his *Anasibirites multiformis* (1922, pl. clxxi, figs. 11-14). This author, in fact, stated (p. 144) that his form from Timor no longer resembled the Sibiritids, but looked more like *Meekoceras*; and the writer (1921, p. 300) directed attention to the resemblance between the Spitsbergen forms, recorded as "*Goniodiscus*" and *Prionites*, to *Anasibirites* on the one hand, and to Stephanitids on the other. It has already been mentioned (*supra*, p. 244) that Prionitidæ are believed to be closely allied

to the Meekoceratidæ; and they are here separated from this family merely on account of their developing tubercles, and of their assumed affinity with Sibiritids and the allied families discussed below. It may be held with v. Krafft (in v. Krafft and Diener, 1909, p. 130) that there is some probability of the Meekoceratidæ being also the root from which *Sibirites* itself has branched off. This derivation, however, cannot be based on the presence of a smooth venter in the immature *Anasibirites*, as v. Krafft suggested; and the resemblance of Welter's *Anasibirites multiformis* IX to *Hemiprionites* and *Meekoceras* is easily explained by assuming cœnogenetic appearance of the plication in the young of *Anasibirites*. In any case the three Timor forms of *Prionites* lately described and figured by Welter (1922, pl. clxvi, figs. 8-16), with different types of suture-line and ornamentation, are somewhat different from the Salt Range forms, and come from the *Owenites* Beds, *i. e.* from below the prolific *Anasibirites* horizon, in which apparently *Prionites* of the larger and more inflated Salt Range type may be expected to occur.

Gurleyites is included here because J. P. Smith identified it with *Hemiprionites*, showing that it is at least a close ally. But in the interpretation here adopted, *Gurleyites* is at least as close to *Wasatchites* as it is to *Hemiprionites*, and therefore might equally well have been grouped with the Sibiritidæ.

Genus PRIONITES, Waagen.

1895, p. 52; Diener, 1915a, p. 227.

GENOTYPE. *Prionites tuberculatus*, Waagen, 1895, p. 58, pl. v, fig. 2.

DIAGNOSIS. Massive, discoidal Prionitidæ, with fairly open umbilicus, subtabulate or rounded venter, and lateral blunt spines or tuberculated ribs. Suture-line with three large, rounded saddles and saw-like auxiliaries.

DISTRIBUTION. Upper Eo-trias, Owenitan and Columbitan?. Salt Range; Himalayas; Timor.

REMARKS. Philippi (1901, p. 104) considered *Prionites* to be close to *Prionolobus*, but the resemblance in suture-line is superficial, the large, rounded saddles of the former and the coarse dentition of the lobes being the more obvious distinctions. In the earlier genus the prionidian auxiliaries are connected with the widening of the whorl-sides in *Prionites* and, apparently, with the development of a high umbilical wall; for according to v. Krafft (in v. Krafft and Diener, 1909, p. 120) such a transitional

form as "*Ceratites*" *murchisonianus*, Waagen (1895, p. 43, pl. iv, figs. 1*a*, *b*), which leads directly to *Prionites trapezoidalis*, Waagen (1895, p. 56, pl. vi, figs. 1*a*, *b*), has a true "*Meekoceras*" suture-line. It is also to be noted that the allied "*Ceratites*" *patella*, Waagen (1895, p. 51, pl. iv, fig. 2), was already considered by v. Krafft to be a Sibiritid.

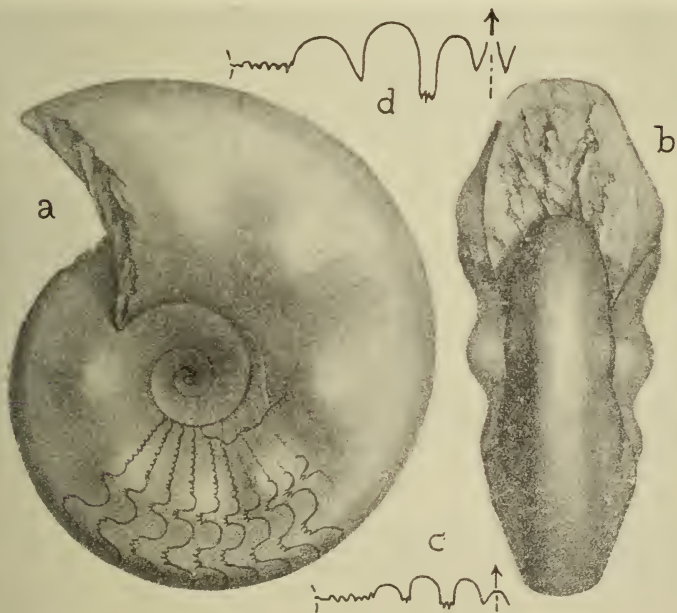


FIG. 113.—*a-c*, *Prionites tuberculatus*, Waagen. Side- and peripheral views and suture-line of holotype from the Upper Ceratite Limestone, Chidroo, Salt Range. *d*, Suture-line of *P. linguatus*, Waagen. Same formation, Koofri. (After Waagen, 1895, pl. v, figs. 2*a-c*, and pl. vi, fig. 4*b*.)

The Salt Range forms (not represented in the Collection) seem to be quite distinct from the groups here referred to Sibiritidæ; but Welter (1922) has lately figured some allied species from Timor; and the development of his *Prionites lævis* (p. 134, text-fig. 13), considered to be close to, if not specifically identical with, Waagen's *P. undatus*, indicates that the Arctic forms described below among the Sibiritidæ are probably corresponding offshoots of the same Meekoceratid

parent-stock that gave rise to the restricted *Prionites*—a stock which includes the Arctoceratidæ and Dagnoceratidæ in the wider sense.

Prionites lævis, Welter.

1922, p. 134, pl. clxvi, figs. 8, 9 (lectotype), 10 ; 1933, Kutassy, p. 621.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustum-bilicate *Prionites*. Whorl-section first subrectangular with parallel whorl-sides ; later subhexagonal, owing to the sloping umbilical wall becoming very high. Venter tabulate. Test smooth, with faint sigmoidal striæ of growth. Suture-line with three saddles and straight, serrated line of auxiliaries.

MEASUREMENTS :

Lectotype	.	.	.	82	.	·44	.	·37	.	·18
C. 33960	.	.	.	58	.	·46	.	·40	.	·17

REMARKS. This species is represented by one typical example, and a variety with a narrower and subsulcate periphery that may represent an entirely new form. Its whorl-section is subgaleate, and the test is thin on the outer half, but greatly thickened at the umbilical end. Its suture-line is similar to that of the more typical example, but the auxiliaries are not exposed.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan. Timor.

SPECIMENS :

C. 33960. Toeboelopo, Timor. *M. E. Walsh Coll.*, 1930.

C. 33959 (var. nov.). Toeboelopo, Timor.
M. E. Walsh Coll., 1930.

Genus **HEMIPRIONITES**, Spath.

1929, p. 270 (= *Goniodiscus*, Waagen, 1895, p. 126, *non* Mueller and Troschel, 1842, p. 57).

GENOTYPE. "*Goniodiscus*" *typus*, Waagen, 1895, p. 129, pl. ix, figs. 8a-c (lectotype), 7-10.

DIAGNOSIS. Rather involute, discoidal Prionitidæ, with flat, almost smooth, sides and tabulate venter. Indistinct serration of ventro-lateral edges and transverse ribs on periphery, as in *Anasibirites*. Suture-line ceratitic, as in *Prionites*, but with short auxiliary series.

DISTRIBUTION. Upper Eo-trias, Owenitan. Salt Range ; Timor ; Utah ; Spitsbergen ; (Siberia ?).

REMARKS. The Arctic "*Xenodiscus*" *dentosus*, Mojsisovics (1886, p. 78, pl. xi, figs. 12a, b), which was listed by Diener

(1915a, p. 135) as the only other "*Goniodiscus*", differs from the Salt Range type as much as it does from the Spitsbergen form here described. It may be more closely allied to those evolute "*Xenodiscus*" of the type of "*X.*" *schmidtii*, Mojsisovics (1886, p. 77, pl. xi, figs. 8-10 only), that occur with it in the Olenek fauna, and have already been referred to as showing affinities with *Svalbardiceras* and other Meekoceratidæ and Arctoceratidæ.

More typical forms of *Hemiprionites* have since been recorded from Utah, and as the Timor species described below is connected by transitions and has, indeed, been identified, specifically, with undoubted *Anasibirites*, the systematic position of

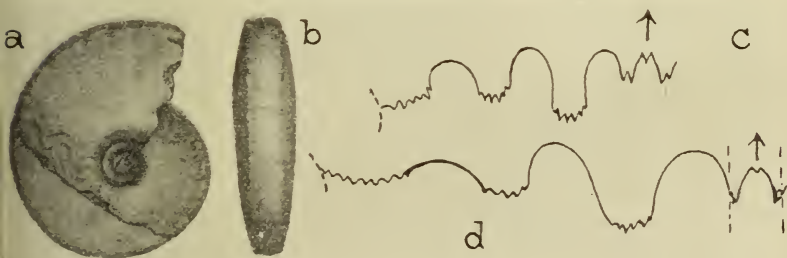


FIG. 114.—*Hemiprionites typus* (Waagen). *a*, *b*, Side- and peripheral views of lectotype, and *c*, suture-line of a larger fragment. Lower Trias, Upper Ceratite Limestone. Chideru, Salt Range. (After Waagen, 1895, pl. ix, figs. 8a, *b*, 9 = "*Goniodiscus*.") *d*, *Arctoprionites nodosus* (Frebald). Suture-line (enlarged $\times 3$) of the example figured in Pl. XVI, fig. 5, from the Lower Trias of Spitsbergen (C. 27199.)

the present genus is definitely known. But to consider it a mere sub-genus of *Anasibirites*, as J. P. Smith did, would be a return to that comprehensive interpretation of Triassic ammonites which prevailed before the appearance of Waagen's great Salt Range work.

Hemiprionites timorensis, nom. nov.

1922. *Anasibirites multiformis*, *partim*, Welter, p. 138, pl. clxxi, figs. 13, 14 (form IX).

DIAGNOSIS. *Hemiprionites* like *H. typus*, but with less concentric coiling and periphery often provided with spiral striation.

MEASUREMENTS :

Welter, pl. clxxi, figs. 11, 12	.	12	·56	(?)	·11
„ „ figs. 13, 14	.	51	·53	·32	·07 (?)
C. 34197	.	32	·53	·26	·15
C. 34198	.	45	·51	·24	·11
C. 34199	.	58	·52	·30	·12
C. 34200 (transition to <i>Anasibirites multiformis</i>)	.	70	·51	·28	·15

REMARKS. This species is connected with *Anasibirites multiformis*, Welter, by many transitions, one of which is represented by the example figured in Welter's pl. clxxi, figs. 6, 7, also figs. 4, 5. There are many such specimens in the Collection. J. P. Smith (1932, p. 76) identified these with "*Goniodiscus*" *typus*, Waagen; but it is significant that Welter already had associated these two examples of his form VIII with the more evolute specimens illustrated in figs. 1-3 and 8-10 of his pl. clxxi, and the former, at any rate, was left by J. P. Smith in the variable species *Anasibirites multiformis* (see p. 346).

Two of the examples listed above (C. 34197-8) are more compressed than Welter's larger specimen (figs. 13, 14), which may be chosen as the holotype of the present species. They may represent a slender variety, but the larger of them has also very distinct falcoid ornamentation. Irregularities in the striation in other examples may produce wavy ventro-lateral edges; and tranverse ribbing of the periphery, rather than longitudinal striation, also often occurs, some of the specimens being slightly malformed, or asymmetrical. Development of almost *ibex*-like, but transitory, ornamentation on the body-chamber, or at an earlier stage, is less frequent; a distinct constriction was observed in only one example (C. 34202). Again, the rounding of the ventral edges may set in at an earlier stage than in the holotype, and the width of the umbilicus may vary as much as the thickness.

In one large specimen (C. 34201) of 92 mm. diameter, which, however, is a distinct transition to *Anasibirites multiformis*, the body-chamber is complete and occupies just over half a whorl. The suture-line is shown on a few specimens, and agrees with that of the species just mentioned.

HORIZON AND LOCALITIES. Upper Eo-trias, *Anasibirites* Beds. Timor.

SPECIMENS :

C. 34197-34290. Toeboelopo, Timor.

M. E. Walsh Coll., 1930.

C. 37187. Toenioen Eno, Timor.

Same Coll.

Hemiprionites americanus, Mathews.

1929, p. 32, pl. v, figs. 22-27 (*Goniodiscus*); 1932, J. P. Smith, p. 76,
(*Anasibirites* [*Goniodiscus*] *typus*).

DIAGNOSIS. *Hemiprionites*, with typical, compressed, smooth, and fairly involute shell, tabulate venter, and ceratitic suture-line. Keels, bordering more or less broad peripheral area, rather distinct.

MEASUREMENTS :

Holotype (Mathews)	43	. . .	50	. . .	28	. . .	14
36129	50	. . .	50	. . .	26	. . .	14

REMARKS. J. P. Smith united this species with *H. typus* (Waagen), the genotype, and included in the synonymy also *H. shumardi* and *H. slocomi* (Mathews), which seems correct so far as the American forms are concerned. For, although *H. walcotti* is here kept separate, for descriptive purposes only, the Utah forms are all members of just one species-group; and differences in dimensions, or more-or-less distinctness of the ventro-lateral keels, are of little significance. On the other hand, it seems preferable not to identify the Utah examples with the Salt Range type, until the latter is more completely known and can be carefully compared with the well-preserved American material.

The apparent differences between *H. typus*, as described by Mathews (and quoted in J. P. Smith), *H. americanus*, and some of the other Utah species are enhanced by errors in the measurements, *e.g.* where the umbilicus of *H. typus* is described as being more than one-fourth the diameter of the shell or that of *H. butleri*, Mathews sp. (p. 35) is given as 82%.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan (*Anasibirites* Beds). Fort Douglas Military Reservation, Utah, U.S.A.

SPECIMENS :

C. 36129-36134.

C. A. Matley Coll., 1930.

Hemiprionites walcotti (Mathews).

1929, p. 32, pl. vi, figs. 1-5; (*Goniodiscus*) 1932, J. P. Smith, p. 76 (*Anasibirites* [*Goniodiscus*] *typus*).

DIAGNOSIS. Like *H. americanus*, but with higher and more compressed whorls and smaller umbilicus.

MEASUREMENTS :

Holotype	.	.	.	39	.	.59	.	.25	.	.06
C. 36135	.	.	.	27	.	.56	.	.24	.	.10

REMARKS. The umbilicus, at smaller diameters, is wider than in the adult, but the narrow periphery is, perhaps, a readier means of distinguishing this "species" from *H. americanus*, at least in the young. At over 50 mm. diameter the form is rather more distinct, but the preservation of at least two out of the three larger examples here doubtfully attributed to the present species is such that they could not safely be differentiated from forms of *Meekoceras*.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan (*Anasibirites* Beds). Fort Douglas Military Reservation, Utah, U.S.A.

SPECIMENS :

C. 36135-8.

C. A. Matley Coll., 1930.

Hemiprionites utahensis (Mathews).

1929, p. 33, pl. vi, figs. 29-31 (*Goniodiscus*); 1932, J. P. Smith, p. 77, pl. lxxx, figs. 9, 10 (*Anasibirites* [*Goniodiscus*]).

DIAGNOSIS. Like *H. americanus*, but with wider periphery.

MEASUREMENTS :

Holotype	.	.	.	51	.	.49	.	.31	.	.19
C. 36146	.	.	.	37	.	.49	.	.33	.	.17

REMARKS. This form also is probably based merely on individual variations of *H. americanus*; but the broad venter, with its "undulations producing a wavy appearance", is rather distinctive. A similar ventral aspect is noticeable in forms of *Arctoprionites* (e. g. Pl. XVII, figs. 1, 6), but *H. garwoodi* (Pl. XVII, fig. 3) is considerably more compressed.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan

(*Anasibirites* Beds). Fort Douglas Military Reservation, Utah, U.S.A.

SPECIMENS :

C. 36146.

C. A. Matley Coll., 1930.

Hemiprionites ornatus (Mathews).

1929, p. 34, pl. vi, figs. 6-10 (*Goniodiscus*) ; 1932, J. P. Smith, p. 75, pl. lxxx, figs. 11, 12 (*Anasibirites* [*Goniodiscus*]).

DIAGNOSIS. Like *H. americanus*, but with striæ of growth united into more or less distinct bundles or folds, most prominent on inner half of lateral area.

MEASUREMENTS :

Holotype (Mathews)	.	.	30.7	.48	.31	.15
C. 36140	.	.	37	.47	.30	.17

REMARKS. This form, again, is believed to include merely those individuals of the common *H. americanus*, in which the sigmoidal striæ of growth are bundled into folds, for there are transitions to the smooth types, and the folding is not always accompanied by that slight increase in thickness and width of umbilicus that might appear a distinctive feature from the table of measurements. The indistinct siphonal ridge of the venter, mentioned by Mathews, also may, or may not, be noticeable, and the width varies, as does the prominence of the ventro-lateral edges.

One doubtful example (C. 36155) with very narrow, bicarinate periphery, as in *H. butleri*, Mathews sp. (1929, p. 35, pl. vi, figs. 18-21), is almost ribbed on the earlier whorls, like the associated *Anasibirites*, but like the body-chamber of a large individual (C. 36156), about 75 mm. in diameter, it is too poorly preserved for separate description. Another specimen (C. 36157), which might perhaps represent the inner whorls of *Gurleyites smithi*, Mathews (1929, p. 43, pl. x, figs. 1-6), is included here only because at 45 mm. diameter it has already three-quarters of a whorl of body-chamber ; but the folds are very faint at that stage.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan (*Anasibirites* Beds). Fort Douglas Military Reservation, Utah, U.S.A.

SPECIMENS :

C. 36140-5, 36155-7.

C. A. Matley Coll., 1930.

Hemiprionites garwoodi, sp. nov.

Plate XVI, figs. 1, 3; Plate XVII, figs. 3, 5.

1921. *Goniodiscus* spp., Spath, p. 300.

DIAGNOSIS. Platygyral, substenogyral, subangustumbilicate *Hemiprionites*. Sides flattened, with striæ of growth on chambered portion, and a few irregular folds on body-chamber. Periphery tabulate, with faint transverse ribs; edges tending to become crenulate, especially on outer whorl. Umbilical slope rounded. Suture-line intermediate between that of *Arctoprionites nodosus* and *Hemiprionites typus* (figs. 114c, d, p. 331).

MEASUREMENTS :

Holotype (Pl. XVI, fig. 1)	. 49	? .47	.31	.18
Paratype (Pl. XVI, fig. 3)	. 50	.49	.30	.18

REMARKS. The holotype of this form was first described as a new species of "*Goniodiscus*", with coarse pleats at the middle of the side, near the end of the shell, and thus transitional to *Prionites*. It is now united specifically with the two specimens, also originally referred to "*Goniodiscus*", which were stated to be "closely comparable to *Meekoceras gracilitatis*, White, but having a slightly broader periphery". In one of these specimens now figured (Pl. XVI, fig. 3) the lateral folds are only very slightly less conspicuous than in the holotype; in the other the shape is more "*Meekoceratid*", but near the aperture, again, there is the characteristic bulging. The notching of the peripheral edges and slight ribbing across the venter also make it probable that this third example must be referred to the same species as the other two.

The suture-line of this "new species of *Goniodiscus*" was said to agree with that of *H. typus*, Waagen, but to have a slightly wider external saddle. The subdivided external lobe seems identical, but the first lateral lobe has only four and the second only three denticulations, and the second lateral saddle is lower.

The "young examples" referred to the same species and having the costation of *Anasibirites* may belong to the form described below as *Gurleyites freboldi*, but are too immature to be definitely identified.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?. Spitsbergen.

SPECIMENS :

C. 27156. Trident, Sassendal.

27153-54, Base of Trident, Sassendal.

? **C. 27197-8.** Trident, Sassendal. *J. W. Gregory Coll.*, 1896.

Genus **GURLEYITES**, Mathews.

1929, p. 42.

GENOTYPE. *G. smithi*, Mathews, 1929, p. 43, pl. x, figs. 1-6.

DIAGNOSIS. More-or-less compressed Prionitidæ, with *Hemiprionites*-like, tabulate inner whorls, but excentrumbilicate, and with rounded body-chamber, tending to become inflated. Ornamentation consisting of more-or-less straight ribs, occasionally bullate at the umbilical border, degenerating on the body-chamber. Suture-line ceratitic, as in *Hemiprionites*.

DISTRIBUTION. Upper Eo-trias, Owenitan (*Anasibirites* Beds). Utah; Spitsbergen.

REMARKS. J. P. Smith, in curtly "dropping" *Gurleyites* and stating it to be a typical *Goniodiscus* (1932, p. 76), may have been influenced by the fact that *G. smithi*, the genotype, itself is somewhat transitional, its inner whorls resembling typical *Hemiprionites*. But, interpreted by species like *G. milleri* and *G. bastini*, Mathews, and by the example referred below to the latter form, *Gurleyites* seems to be transitional between *Anasibirites* and *Wasatchites* rather than between *Anasibirites* and *Hemiprionites*, and the development of bullate inner tubercles alone is sufficient for generic separation. In *Arctoprionites* the tubercles are developed on the middle of the sides, and are far more prominent, especially on the body-chamber, but both genera are connected with *Hemiprionites* by transitions.

Gurleyites bastini, Mathews.

1929, p. 44, pl. x, figs. 7-11; J. P. Smith, 1932, p. 70, pl. lxxx, figs. 3-5 (*Anasibirites*).

DIAGNOSIS. *Gurleyites* with prominent ornamentation, almost as in *Wasatchites meeki* (p. 354), but with greater compression and an inflated, excentrumbilicate body-chamber, with smooth, rounded periphery.

MEASUREMENTS :

Holotype (Mathews) . . . 53 . 41 . 26 . 26

REMARKS. The Utah example in the Collection is fragmentary, but retains part of the body-chamber as far as the mouth-border. Moreover, it is about twice the size of the holotype, and therefore has an appearance somewhat different from that of any of the species of *Gurleyites* figured by Mathews. But the differences are believed to be of less than specific importance, and, while

the inner whorls are comparable to the form figured by Mathews as *G. milleri* (1929, p. 45, pl. ix, fig. 10), the rounded body-chamber near the end has the sharp, comma-shaped, umbilical

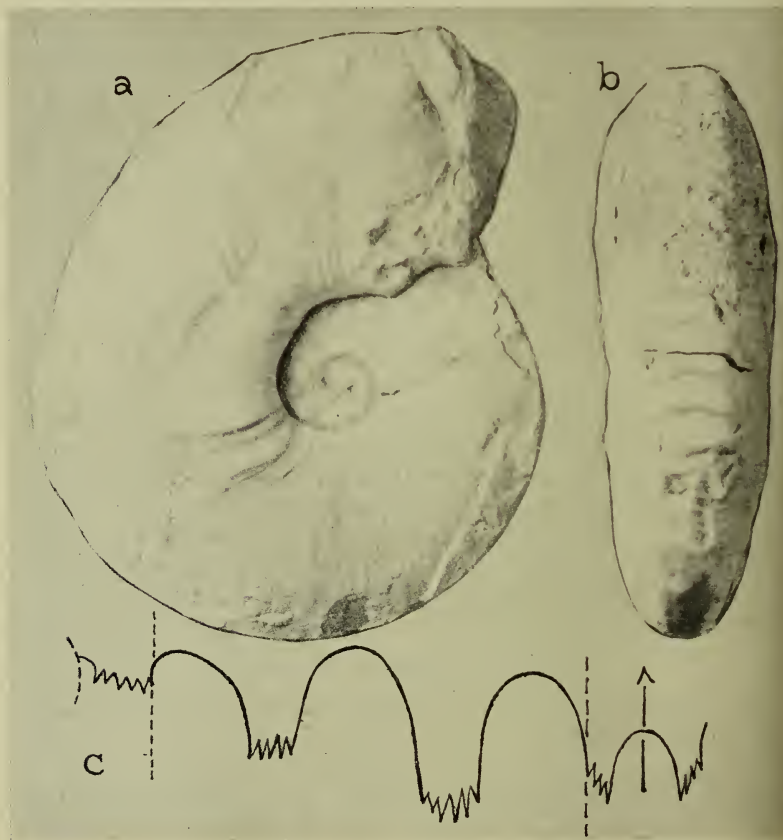


FIG. 115.—*Gurleyites smithi*, Mathews. *a, c*, Side-view and external suture-line ($\times 2$) of holotype, and *b*, peripheral view of a paratype. Upper Eo-trias, *Anasibirites* Beds. Utah. (After Mathews, 1921, pl. x, figs. 1, 4, 5.)

nodes represented in Mathews's *G. bastini* (pl. x, fig. 7). It is, however, possible that, on the discovery of better material, the example here described may turn out to belong to a new species, somewhat transitional to *Arctoprionites*.

HORIZON AND LOCALITIES. Upper Eo-trias, Upper Owenitan,

Anasibirites Beds. Fort Douglas Military Reservation, Utah, U.S.A.

SPECIMENS :

C. 36139.

C. A. Matley Coll., 1930.

Another body-chamber fragment in the same collection (C. 36154), unfortunately almost unrecognizable, seems to have belonged to a form like *G. smithi*, Mathews (1929, p. 43, pl. x, figs. 1-3), but it is difficult to compare with the inner whorls (C. 36157), referred to under *Hemiprionites ornatus* (p. 335).

***Gurleyites freboldi*, sp. nov.**

Plate XIV, figs. 3*a*, *b*, 7*a*, *b*; Plate XV, figs. 1*a*-*c*.

1921. *Anasibirites* sp., Spath, p. 301.

1930. *Anasibirites* sp., Frebold, p. 11.

DIAGNOSIS. Subplatygyral, substenogyral, subangustumbilicate *Gurleyites*. Whorl-sides flattened, with greatest thickness near the rounded umbilical edge; venter subtabulate. Inner whorls with prorsiradiate ribs, thickened near the ventro-lateral edges and some (at intervals) also near umbilical edge. The later ribbing tends to become faint and irregular, and only a few folds may remain on the inner half of the whorl side, with indistinct notches across the periphery. Suture-line with more individualized auxiliary lobe than in *Arctoprionites*.

MEASUREMENTS :

Holotype (Pl. XV, fig. 1)	. 47	. 47	. 32	. 23
C. 21726 (Pl. XIV, fig. 3 <i>b</i>)	. 18	. 47	. 30	. 20
C. 27159 (Pl. XIV, fig. 7)	. 34	. 44	. 34	. 24

REMARKS. The holotype is the "curious new form, transitional to *Goniodiscus*", to which I previously referred; and it owes its different aspect, as compared with the other twelve specimens of "*Anasibirites*", to the comparative smoothness of the outer whorl. It is now, however, believed to be specifically identical with the example figured in Pl. XIV, fig. 7 (no. 3 of the above measurements), in which the last half whorl (body-chamber) is still distinctly costate. The well-developed inner bullæ of some of the ribs are not found in the Salt Range species of *Anasibirites*, with which the Spitsbergen forms had at first been compared, but the young of *A. kingianus*, Waagen sp. (1895, pl. viii, fig. 2), has similar, strengthened ribs at intervals. The Himalayan forms are closer, *e. g.* "*Sibirites*"

robustus and "*S.*" *spiniger*, v. Krafft (in v. Krafft and Diener, 1909, pl. xxxi, figs. 1, 2), but do not apparently belong to the same stock, as was mentioned in discussing the genus.

HORIZON AND LOCALITIES. Upper Eo-trias, *Posidonomya* Beds (Columbitan ?). Spitsbergen.

SPECIMENS :

C. 21726-8, 27157-66. Nodule Bed, Trident, Sassendal.

Collected and presented J. W. Gregory and

E. J. Garwood, 1896.

Genus **ARCTOPRIONITES**, Spath.

1930, p. 86.

GENOTYPE. *A. nodosus* (Frebold), 1930, p. 8, pl. i, fig. 7 (1-6).

DIAGNOSIS. More-or-less involute, discoidal Prionitidæ, with tabulate venters, tending to develop crenulation of the latero-peripheral edges, and costation or tuberculation on the whorl-sides. Suture-lines as in *Hemiprionites*, but with large external saddle and a simple external lobe (fig. 114d, p. 331).

DISTRIBUTION. Upper Eo-trias, Upper Owenitan (*Anasibirites* Beds) to Columbitan ?. Spitsbergen.

REMARKS. The inner whorls of some of the forms described below (as of certain *Gurleyites*) may show resemblance to immature *Anasibirites*, and were first recorded as such (Spath, 1921, p. 301). In the adult the shape becomes more Meekoceratid, and on the body-chamber the characteristic folds appear elongated, not rounded as in *Prionites*. In *Arctoprionites nodosus*, also in the large unnamed species, transitional to *Wasatchites*, and figured in Pl. XVIII, fig. 1, these bullate folds are very conspicuous, but not in *A. tyrrelli*, which is less tuberculate. The three forms, however, although as yet incompletely known, belong to one fairly homogeneous group, differing from *Gurleyites* in the high position of the lateral tubercle. *Prionites* sp. ind., figured by Frebold (1930, pl. iii, fig. 7), probably also belongs to this group, and the same author's "*Goniodiscus*" sp. nov. aff. *nodosus* (1930, pl. ii, figs. 1, 1a), is another new species.

Arctoprionites nodosus (Frebold).

Plate XVI, fig. 5 ; Plate XVII, fig. 1.

1921. *Prionites* sp. nov., Spath, p. 301 ; 1930, Frebold, p. 8, pl. i, figs. 6, 7 (1-5 ?), pl. ii, fig. 2.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Arctoprionites*. Chambered part with flat sides, rounded

umbilical slope, truncate (subsulcate) periphery, and faint, slightly biconcave and somewhat irregular striæ. Body-chamber with widening umbilicus, high, but gentle umbilical slope, five or six bullate spines near middle of the whorl side, and indistinct broad ribs on outer half, making the periphery irregular and notched. Suture-line (fig. 114*d*, p. 331) with low second lateral saddle and auxiliary series ascending to umbilical suture.

MEASUREMENTS :

Lectotype (Frebold, pl. i, fig. 7) .	79	·41	(?)	·25
C. 27199 (Pl. XVI, fig. 5) .	65	·43	·34	·23

REMARKS. When first recording this form I stated that in the character of the inner whorls it resembled the species now described as *Hemiprionites garwoodi* and *A. tyrrelli*; also that these inner whorls were more evolute than the somewhat similar "*Meekoceras*" *sibiricum*, Mojsisovics (1886, p. 85, pl. xi, figs. 1-6), and in this respect showed more likeness to *M. sp. ind. aff. jolinkense* (non v. Krafft) in Diener (1913, p. 25, pl. iv, fig. 3). The outer whorl, *i. e.* body-chamber, on the other hand, was said to agree with that of the example of *Prionites tuberculatus* (Waagen) figured by Frech (1905, pl. xxviii, fig. 2). This resemblance again is superficial, for the sharply truncated periphery of the species here described suggests affinity rather with what I called the "*Goniodiscus*"-*Anasibirites* stock. Considering the genotype of *Prionites*, however, to be an earlier species, I thought it possible that the Spitsbergen forms did not belong to the genus *Prionites*. Although Frech's *P. tuberculatus* is apparently closer to the present form than is Waagen's (possibly idealized) original figure, it is necessary to separate the Arctic species from these earlier true *Prionites*.

The large and fragmentary specimen previously recorded as *Prionites sp. nov. aff. tuberculatus*, Waagen, has a more rounded outer whorl, and was stated to suggest strikingly a transition to "*Keyserlingites*". The side view and peripheral aspect of the body-chamber are now given (Pl. XIV, fig. 4, and Pl. XVIII, figs. 1*a*, *b*), but the earlier whorls are poorly preserved, although it seems that at the diameter of the lectotype of the present species they are more involute and more rounded peripherally. The tuberculation is that of *Prionites* on the chambered portion, and of the species of *Arctoprionites*, now described, on the body-chamber; so that, in spite of its resemblance to "*Keyserlingites*", this fragment must be considered to form another of those numerous transitions that connect

the *Prionitidæ* and *Sibiritidæ*. It may, perhaps, belong to the same un-named species as the "*Goniodiscus*" sp. nov. aff. *nodosus*, figured by Frebold (1930, pl. ii, fig. 1).

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ? Spitsbergen.

SPECIMENS :

C. 27199. Trident, Sassendal. *J. W. Gregory Coll.*, 1896.

? **C. 27212** (sp. nov. ?). Nodule Bed.

Same locality and collection.

***Arctoprionites tyrrelli*, sp. nov.**

Plate XIV, fig. 5 ; Plate XVII, fig. 6.

1921. *Goniodiscus* ? sp. (third form), Spath, p. 301.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Arctoprionites*. Whorl-sides flattened, with falciradiate striæ on the chambered portion, and ribs on the body-chamber, distinctly bullate at the middle of the side, and ending at the sharp periphero-lateral edge with a faint clavus. Venter tabulate, subcostate transversely. Umbilical slope rounded. Suture-line as in *A. nodosus*, but with the second lateral saddle almost at the umbilicus ; external lobe slightly asymmetrical.

MEASUREMENTS :

C. 27155 (Pl. XIV, fig. 5) . 35 . 46 . 36 . 19

REMARKS. This species was at first described as having the coarse pleats at the middle of the side, *i. e.* the "*Prionites*-folds", much more closely set ; also as resembling in shape *Anasibirites hircinus*, Waagen sp. (1895, p. 123, pl. ix, fig. 4). In that form, however, the costæ are pronounced on the outer half of the whorl-side, where they are weakened in the species here described, and the periphery is also more distinctly costate in *A. hircinus*. A similar type of costation, however, is found in *Sibirites eichwaldi*, Keyserling (see especially Mojsisovics, 1886, pl. x, fig. 3a), but here, again, the peripheral aspect is different.

The whorl-section of *A. tyrrelli*, as of *Hemiprionites garwoodi*, was stated to approach that of *Prionites tuberculatus*, Waagen, but in the second species particularly, with the lateral folds appearing only near the end of the shell, the Meekoceratid aspect of the chambered whorls is characteristic, the resemblance to the true *Prionites* being superficial.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan ?.
Spitsbergen.

SPECIMENS :

C. 27155. Base of Trident, Sassendal.

J. W. Gregory Coll., 1896.

B. Family SIBIRITIDÆ, Mojsisovics emend.

1896, p. 615 ; 1899, p. 49.

DIAGNOSIS. More-or-less distinctly ribbed or tuberculate developments of Meekoceratidæ with differentiation of the periphery ranging from mere widening and transverse striation to sulcation.

REMARKS. As here emended, this family comprises a number of genera, ranging from *Sibirites* and *Anasibirites* to *Keyserlingites*, *Wasatchites* and *Durgaites* ; whilst the Upper Triassic *Metasibirites* and *Thetidites* are believed to be entirely independent developments, as suggested already by v. Krafft (in v. Krafft and Diener, 1909, p. 127). *Hemiprionites* and *Arctoprionites*, as already mentioned, connect the Sibiritidæ directly with *Meekoceras* and the restricted *Prionites* ; the former ("*Goniodiscus*") had been included already by Hyatt in *Prionitidæ*.

The ornamentation of *Sibirites eichwaldi*, even if exaggerated, is not unlike that of the form here described as *Arctoprionites tyrrelli*, sp. nov. ; and the Timor assemblage, included both by Welter and myself in a comprehensive species *Anasibirites multiformis* covers forms that range from *Hemiprionites* almost to *Wasatchites* (connected with the first by numerous transitions, but most of them showing *Anasibirites* characters) ; yet all these genera form a fairly homogeneous group. *Olenikites*, believed to be a simplified stock, evolved alongside of *Keyserlingites*, shows affinity also with other families, *e. g.* the *Tirolitidæ* and *Dinaritidæ*, and is only provisionally included in the present family.

Genus SIBIRITES, Mojsisovics.

1886, p. 58 ; Diener, 1915a, p. 254 (*partim*).

GENOTYPE. *Sibirites pretiosus*, Mojsisovics, 1886, p. 61, pl. x, figs. 10a-c.

DIAGNOSIS. Rather evolute, discoidal Sibiritidæ with sigmoidal costation, thickened on whorl-side and again at

periphero-lateral edges. Venter subtabulate, with more-or-less incomplete fusion of rib-chevrons along the median line. Suture-line with large external saddle, and wide, rounded, lateral saddle.

DISTRIBUTION. Upper Eo-trias, Columbitan or higher ?. Siberia.

REMARKS. Of the numerous species listed by Diener, only the type, cited above, *S. eichwaldi*, Keyserling (see Mojsisovics, 1886, p. 59, pl. x, figs. 1-7, 9), its var. *tenuicostata* (*ib.*, fig. 8) and the new form figured by Mojsisovics in pl. x, fig. 11, are



FIG. 116.—a-c, *Sibirites pretiosus*, Mojsisovics. Side- and two peripheral views of holotype. Lower Trias. Mouth of Olenek River, Siberia. d, e, *S. eichwaldi*, Mojsisovics. Suture-lines of two examples from the same locality. (After Mojsisovics, 1886, pl. x, figs. 10a-c, 2d, 5.)

now considered to be true *Sibirites*. The Himalayan Lower Muschelkalk species, "*S.*" *prahlada*, and "*S.*" *pandya*, Diener, were left by Mojsisovics in the restricted *Sibirites*, but he pointed out that the former species (to be discussed below under *Durgaites*) approached the Norian *Metasibirites*; whilst "*S.*" *pandya*, Diener (1895b, p. 104, pl. xxix, fig. 3), was stated by its author to show considerable differences from the congeneric forms. If at all related to Sibiritids, "*S.*" *pandya*, Diener, may represent an independent offshoot.

The derivation, by Steinmann (1909, p. 13), of the Bajocian-Bathonian *Parkinsonia* and *Zigzagiceras* from the true Arctic *Sibirites* and from "*S.*" *prahlada* respectively, cannot be accepted, as Pompeckj (1910, p. 77) has clearly shown.

Genus **ANASIBIRITES**, Mojsisovics.

Mojsisovics, 1896, p. 615 (= *Pseudosibirites*, Arthaber, 1911, p. 254).

GENOTYPE. *Sibirites kingianus*, Waagen, 1895, p. 108, pl. viii, figs. 1a-c (2a-c).

DIAGNOSIS. Rather involute, discoidal Sibiritidæ, with arched or subtabulate venters and sigmoidal ribs, continuous across, and often thickened on, periphery. Body-chamber generally smooth. Suture-line simple, with wide first and small second lateral lobes.

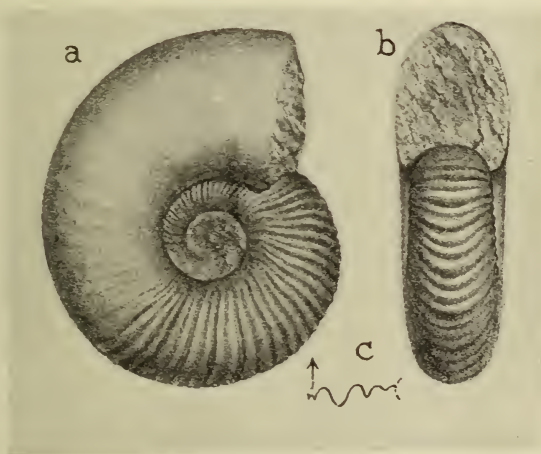


FIG. 117.—a, b, *Anasibirites kingianus* (Waagen). Side- and peripheral views of lectotype. c, *A. dichotomus* (Waagen). Suture-line. Lower Trias, Upper Ceratite Limestone. Chideru, Salt Range. (After Waagen, 1895, pl. viii, figs. 1a, b, 9d.)

DISTRIBUTION. Upper Eo-trias, Owenitan. Salt Range; Himalayas; Timor; California; Utah; Albania?.

REMARKS. It is possible that the numerous species included in *Anasibirites* are a heterogeneous assemblage; but at present it is impossible to separate from the typical Salt Range forms certain incompletely known, and apparently dissimilar, species such as the Californian *A. noettingi*, Hyatt and Smith sp. (1905, p. 49, pl. ix, figs. 1-3). The bed in Timor in which the extremely variable *A. multiformis*, Welter (1922, p. 138, pls. clxix-clxxi), was found, was believed to represent the highest part of the Upper Ceratite Limestone, and to correspond to the zone of "*Sibirites*" *spiniger* of Byans, but these beds are

not the highest of the Eo-triassic sequence, as is generally assumed. I previously recorded *Anasibirites* also from Spitsbergen (1921, p. 301), from a stratum that included "*Keyserlingites*", a genus characteristic of the (probably slightly higher) Upper Eo-triassic Olenek Beds, with true *Sibirites*. The Spitsbergen forms are now included in *Arctoprionites*, since they are connected by transitions with the other forms of that new genus, but they might perhaps have been left in *Anasibirites*, like the equally discoidal and "*Meekoceras*"-like *A. multiformis*, form VIII (Welter, 1922, pl. clxxi, figs. 8-10), or some of v. Krafft's incompletely known Himalayan species.

Anasibirites multiformis, Welter.

1922, p. 138, pl. clxix, figs. 9-27; pl. clxx, figs. 1-19; pl. clxxi, figs. 1-3, 8-10.

DIAGNOSIS. *Anasibirites* with more-or-less strongly and irregularly ornamented early stage and striate or smooth, rounded, outer whorl, rarely showing rejuvenation of ribbing. Body-chamber between half and three-quarters of last volution; mouth-border plain, following the course of slightly sigmoidal striæ. Suture-line ceratitic, simple, as in *Hemiprionites* (fig. 118c, p. 352).

MEASUREMENTS:

Welter, form	I (pl. clxix, figs. 9-11) .	16	·44	·40	·25
"	" V (pl. clxx, figs. 9, 10) .	70	·42	·28	·27
"	" VIII (pl. clxxi, figs. 8-10) .	57	·48	·30	·19
C. 34292	. . . . .	100	·48	·33	·20

REMARKS. In the case of a very variable species like the present, measurements are of little value; and since the suture-line is preserved in only a few examples out of many hundreds, agreement of two given specimens can never be pronounced to be perfect. As regards tabulation or rounding of the periphery, the thickness and form of the whorl-section, the width of the umbilicus (often excentric, notably in the adult), and especially the coarseness of the ornamentation, there is the greatest variability. Welter arranged his 111 examples in nine groups, ranging from the coarsest and most irregular form I to the finely-ribbed forms VI and VII, and leading, by way of the transitional form VIII (partly referred by J. P. Smith to "*Goniodiscus*" *typus*, Waagen), to his extreme form IX, which, however, is here described as *Hemiprionites timorensis*. With the much larger material now available,

many more "forms" in Welter's sense could have been separated, but, as that author suggested, they are evidently merely individual variations of one large species.

The great majority of the examples in the Collection have strongly ornamented inner whorls, like Welter's forms I-V, but in the more finely-ribbed forms VI and VII the same type of ornamentation is visible only in the umbilicus. It is clearly impossible to base "good" species on the earlier or later cessation of ribbing, although the coarse and fine extremes are rather distinct. Thus, one extreme example (C. 34291) is comparable to Welter's figs. 9-11 or 14-16 (pl. clxix) still at 51 mm. diameter, at which there is already half a whorl of body-chamber, but the last four or five stronger ribs are sub-tuberculate near the inner end, almost as in *Wasatchites*. This unique specimen, therefore, is so different from the compressed, smooth examples of the form VII that separate names would seem advisable; yet if these two forms are named, there arises at once the need for distinct designations of all the other forms, both in the series of transitions between the two extremes and special developments outside that series.

One of the variable features that most affects the general aspect of the shells is the more or less pronounced tabulation of the periphery. In the largest, complete example (C. 34292) the ventral area still has distinct edges, like Welter's fig. 12 (pl. clxix), at 100 mm. diameter (body-chamber), but in most of the examples the venter is quite rounded; yet there are tabulate forms in almost every stage of ornamentation, leading to the smooth *Hemiprionites timorensis*. The reason why I do not base another six forms on this series is that they are rare; in one unique extreme (C. 34293), with flattened sides like *A. hircinus*, Waagen sp. (1895, p. 123, pl. ix, figs. 4a, b), the periphery is even sulcate. Here again, however, there are transitions to the normal series, although an angular periphery often causes a peculiar rigidity of the ribbing.

A. robustus, Welter (1922, p. 144, pl. clxxi, figs. 15-17, *non* v. Krafft), is probably not a separate species. There is nothing quite like it among the far richer material in the Collection, but there are at least two examples (C. 34294-5), probably of the form V, in which there is similar rejuvenation of the costation towards the end, in one case still in the septate stage. Since less pronounced ribbing at a late stage is found in other specimens, especially of forms V-VII (*e. g.* C. 34296-7), and since the peripheral sinus is always less conspicuous on the

outer whorls, the examples above mentioned are not now separated from the present species.

Mathews (1929, pp. 10-27) split up a comparable Utah series of *Anasibirites* into a large number of species, and compared them with different varieties of the present form, as follows :

<i>Anasibirites perrini</i> (p. 19)	=	<i>A. multiformis</i>	169/14-15-16.
„ <i>salisburyi</i> (p. 10)	=	„	170/16-17.
„ <i>rollini</i> (p. 27)	=	„	170/16-19.
„ <i>madisoni</i> (p. 11)	=	„	170/11-13.
„ <i>whitfieldi</i> (p. 16)	=	„	170/11-13.
„ <i>crickmayi</i> (p. 17)	=	„	170/11-13.
„ <i>powelli</i> (p. 15)	=	„	170/9-10.

The Utah material in the Collection, unfortunately, is too scanty and too poorly preserved for accurate comparison with the species here described, but *A. salisburyi*, recorded below, in any case is not identical with Welter's form VII or its more compressed individuals, some of which, on account of a more angular venter, are transitional to *Hemiprionites*, *A. blackwelderi*, on the other hand, with its projected costation and narrowly truncate periphery, is quite different from any Timor example.

J. P. Smith (1932, p. 73) adopted a different grouping of the Utah forms, and included also Mathews's *A. alternatus* and *A. romeri* in the species here described, besides making *A. hyatti* a variety of *A. multiformis*. Moreover, he compared some of Welter's forms to Indian species, relying on Waagen's possibly inaccurate figures. And there are again discrepancies, as when the original of Welter's pl. clxix, figs. 17, 18, is taken to be a typical *A. multiformis* on one page (73), and is referred to *A. inæquicostatus*, Waagen (itself considered to be a variety of *A. kingianus*, Waagen), on another (p. 72). This Indian species, here refigured (fig. 117), is also taken to comprise not only the most typical examples of *A. multiformis*, namely Welter's forms I and II (*partim*), but also his form V; but I can not see the likeness to Waagen's figures of this *A. kingianus* or to any of the other Salt Range forms, although these probably constitute a similar species-group, bearing its own, local, stamp.

HORIZON AND LOCALITIES. Upper Eo-trias, *Anasibirites* Beds. Timor.

SPECIMENS :

C. 34291-34420, 37000-37179 (and many duplicates).

Toeboelopo, Timor.

M. E. Walsh Coll., 1930.

Anasibirites salisburyi, Mathews.

1929, p. 9, pl. i, figs. 27-29; 1932, J. P. Smith, p. 74, *partim* (*A. tenuistriatus*).

DIAGNOSIS. *Anasibirites* with *Hemiprionites* whorl-shape, but with rounded ventro-lateral edges, and fine projected striation, more or less uniform throughout.

MEASUREMENTS :

Holotype (Mathews)	. 28	. .52	. .29	. .11
<i>A. "rollini"</i> , Mathews	47	. .49	. .25	. .16
C. 36150	. 30	. .50	. .25	. .20
C. 36148	. 58	. .50	. .26	. .18

REMARKS. The specific name *salisburyi* is adopted only because it is the first used by Mathews for the finely ribbed, but variable, Utah species that was considered by J. P. Smith to be identical with Waagen's *A. tenuistriatus* (1895, p. 124, pl. ix, figs. 1, 2). I am not in favour of this identification, for even among the extremely rich and well-preserved Timor collections in the Museum there is nothing that could be compared to Waagen's figs. 1c-d, although the doubtful type-fragment (1a) could be matched by similar portions of Utah as well as Timor examples. On the other hand, I agree with J. P. Smith in including in one large and variable species a large number of the forms described by Mathews under different names. Thus it will be seen from the table of measurements that the example listed under No. 3 has a larger umbilicus than the typical *A. salisburyi*, and, if it is considered advisable to separate the evolute forms as a var. *rollini*, Mathews (the next name in order of priority), I am quite willing to adopt this variety as well as others for the compressed and more inflated, the very finely, and the more coarsely, striate forms, respectively. Contrary to J. P. Smith, however, I would exclude from the synonymy of the present species *A. mcclintocki*, Mathews (1929, p. 22, pl. iv, figs. 1-6), on account of its different type of ornamentation, although it also clearly is not a good "species", but merely the inner whorls of some larger form.

Mathews (1929, p. 10) included in the synonymy of *A. salisburyi* the variety of *A. multiformis*, figured by Welter (1922) in his plate clxx, figs. 16, 17, but again (p. 27) listed the figs. 16-19 of the same plate in the synonymy of *A. "rollini"*.

It is probable that "*Meekoceras*" *onoii*, Yehara (1928, p. 153, pl. xiii, figs. 1a-c) is merely the Japanese equivalent of the

present species, but the same author's "*Ophiceras*" *multiplacatum* Yehara (1928, p. 162, pl. xiv, figs. 4, 4a) has more distinct ornamentation of the *tenuistriatus* type.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan (*Anasibirites* Beds). Fort Douglas Military Reservation, Utah, U.S.A.

SPECIMENS :

C. 36148-50.

C. A. Matley Coll., 1930.

***Anasibirites blackwelderi*, Mathews.**

1929, p. 13, pl. ii, figs. 10-14; 1932, J. P. Smith, p. 72, pl. lxxix, figs. 11, 12 (*A. hircinus*).

DIAGNOSIS. Like *A. salisburyi*, but more compressed, with narrower and more distinctly tabulate periphery, also more conspicuous ribbing.

MEASUREMENTS :

Holotype	.	.	.	26.9	.	.47	.	.27	.	.19
C. 36147	.	.	.	30	.	.47	.	.27	.	.23

REMARKS. This species was described as being "characterized by its highly compressed condition". In the only example in the Collection, the sharply truncate periphery is distinctly narrower than that of *A. hircinus*, Waagen sp. (1895, p. 123, pl. ix, fig. 4), with which J. P. Smith had identified the present species. Moreover, the ribbing is far more uniform in *A. blackwelderi* and there is considerably more resemblance to the young *A. tenuistriatus*, Waagen sp. (1895, pl. ix, figs. 1c, d). This, however, is also less compressed than the Utah form, and the more typical fragments of *A. tenuistriatus*, represented in Waagen's figs. 1a, b, are, again, far more finely ribbed.

HORIZON AND LOCALITIES. Upper Eo-trias, Owenitan (*Anasibirites* Beds). Fort Douglas Military Reservation, Utah, U.S.A.

SPECIMENS :

C. 36147.

C. A. Matley Coll., 1930.

Genus WASATCHITES, Mathews.

1929, p. 40.

GENOTYPE. *W. perrini*, Mathews, 1929, p. 40, pl. ix, figs. 1-3 (4-9).

DIAGNOSIS. More-or-less evolute, highly sculptured Sibiritidæ with trapezoidal cross-section, wide, tabulate venter, and ceratitic suture-line. Prominent umbilical tubercles, giving

rise to one, two or three ribs that swell slightly at the ventrolateral edges and are continuous (and straight) across the periphery.

DISTRIBUTION. Upper Eo-trias, Upper Owenitan to Columbitan ?. Utah ; Timor ; Spitsbergen.

REMARKS. This genus may well be kept distinct from *Keyserlingites* on account of the differences in the suture-line, especially the external lobe ; but it is difficult to see why Mathews described an obvious member of the present genus as *Keyserlingites seerleyi* (1929, p. 39, pl. viii, figs. 8-10), or why he referred a number of immature *Wasatchites* to the genus *Kashmirites*. In my opinion there is not even superficial resemblance between these genera, and, in Timor at least, *Kashmirites* and *Wasatchites* belong to faunas of different age. Consequently, J. P. Smith's statement that the "supposedly new genus *Wasatchites* agrees in all essentials with typical *Kashmirites*" can only be ascribed to misidentification, which to me is all the more incomprehensible, since "*Kashmirites*" *resseri*, Mathews sp. (Smith, 1932, p. 67, pl. lxxxi, figs. 9, 10), is clearly a *Hemiprionites*, as already suspected by its author.

***Wasatchites orientalis*, sp. nov.**

Fig. 118 p. 352.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Wasatchites*. Whorl-section trapezoidal, with venter narrower than in *W. tridentinus* and ribbing closer than in this species, but coarser than in *W. meeki*. About nine strong and slightly bullate inner tubercles, and three ribs to each, degenerating towards end. Suture-line unknown.

MEASUREMENTS :

Holotype . . . 52 . 44 . 35 . 27

REMARKS. This species differs but slightly from the genotype, *W. perrini*, Mathews, and from *W. magnus*, chiefly in its proportions and in the small size, with degeneration of the lateral and peripheral ornamentation already pronounced at 50 mm. diameter. The unique holotype almost certainly includes the whole of the body-chamber, judging by the striation at the mouth-border, on the side not figured, and by the reduction of the last tubercle. The thickness given above was determined at the end, but at the last tubercle (46 mm. diameter) it amounts to 44%. "*Keyserlingites*" *seerleyi*, Mathews (1929, p. 39,

pl. viii, figs. 8-10), has a wider periphery and more distant and coarser tubercles.

HORIZON AND LOCALITIES. Upper Eo-trias, *Anasibirites multiformis* Bed. Timor.

SPECIMENS :

C. 37180. Toeboelopo, Timor.

M. E. Walsh Coll., 1930.

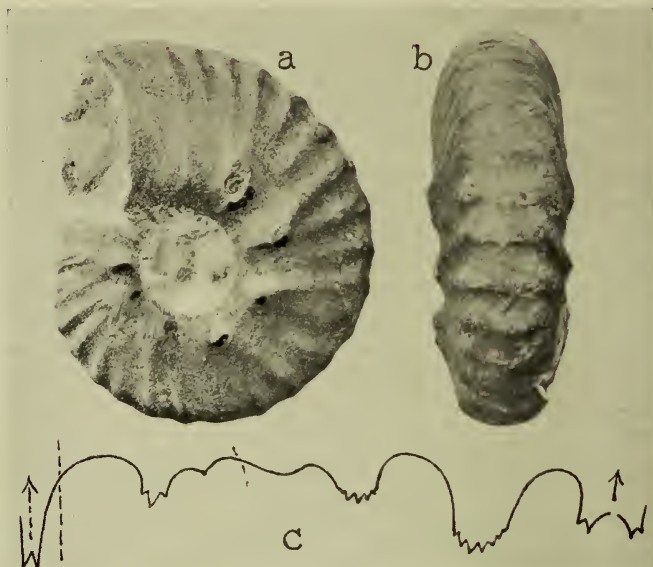


FIG. 118.—*Wasatchites orientalis*, sp. nov. *a, b*, Side- and peripheral views of holotype (B.M., C. 37180) from White *Anasibirites* Limestone. Toeboelopo, Timor. *c*, Complete suture-line of *Anasibirites multiformis*, Welter, from same bed. (Composite, from several examples in the Collection, enlarged by about $2\frac{1}{2}$.)

Wasatchites tridentinus, sp. nov.

Plate XV, figs. 2*a-c*; Plate XVI, figs. 2*a, b*, 4.

1921. *Keyserlingites* sp. nov., Spath, p. 301.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Wasatchites*. Whorl-section subhexagonal, with inner whorls as in *Gurleyites freboldi*, but prominent tubercles appearing on high umbilical edge at diameters of about 25 mm. Three secondaries, with occasional intermediate ribs, to each primary

tubercle; ribs pronounced at the ventro-lateral edges and less so across the periphery. Suture-line ceratitic, with simple, bifid, external lobe.

MEASUREMENTS :

Holotype (Pl. XVI, fig. 4)	.	60	.38	.45	.30
C. 27208 (Pl. XV, fig. 2 <i>b</i>)	.	98	.39	.43	.29
C. 27210 (Pl. XV, fig. 2 <i>a</i>)	.	145	.39	.42	.30
var. involuta (Pl. XVI, fig. 2)	.	87	.46	.45 (?)	.24

REMARKS. This new species was previously described as being close to *K. middendorffi* (Keyserling), but differing in its simpler suture-line. *K. subrobustus*, Mojsisovics sp. (1886, p. 44), based on one of the syntypes of Keyserling's *Ceratites middendorffi* (1845, pl. ii, fig. 4 only), also is very close, but has far more strongly tuberculate inner whorls (compare fig. 119) and a different whorl-section; also the serrated external lobe of *K. middendorffi*. The more compressed *K. schrenki*, Mojsisovics sp. (1886, p. 42, pl. iv, fig. 1), with its flattened outer whorl, differs not only in the almost complete absence of secondary thickenings at the ventro-lateral edge, but also in the considerably lower position of its small and more rounded umbilical tubercles.

The form figured in Pl. XVI, figs. 2*a*, *b* (No. 4 of above table of measurements) has a higher whorl-section and a smaller umbilicus than the typical specimens. It may be separated as a var. *involuta*, but it is slightly crushed, so that it is impossible accurately to measure the thickness, which probably did not differ considerably from that of the holotype, in spite of the compressed appearance of this example. The lateral tubercles are also less prominent in this variety, but the suture-line is identical.

W. perrini, Mathews, the genotype, with similar but more projected suture-line, is more inflated, and *W. meeki*, described below, has only slightly thickened primary ribs, like *Anasibirites robustus*, v. Krafft sp. (in v. Krafft and Diener, 1909, pl. xxxi, fig. 1). The Timor *W. orientalis* differs chiefly in the feebleness of its tubercles and the less prominent peripheral ribbing.

HORIZON AND LOCALITIES. Upper Eo-trias, *Posidonomya* Beds, Spitsbergen.

SPECIMENS :

C. 21724-5, 27205-9, 27210-11. Lower Nodule Bed (Lower Limestone), Trident (West Trident), Sassendal.

E. J. Garwood and J. W. Gregory Coll., 1896.

Wasatchites meeki, Mathews.

1929, p. 41, pl. vii, figs. 1-3 ; pl. viii, figs. 11-14 ; J. P. Smith, 1932, pl. lxxxi, figs. 1, 2 (*Kashmirites*).

DIAGNOSIS. *Wasatchites* with more compressed trapezoidal whorl-section and narrower and deeper umbilicus than *W. perrini*, also more delicate ornamentation than the other species here described.

MEASUREMENTS :

Holotype (Mathews)	. 43.5	. 48	. 37	. 26
C. 36153	. 45	. 44	. 38	. 23

REMARKS. The only examples of *W. magnus* in the Collection are two large whorl-fragments ; and comparison with the present species is difficult. J. P. Smith identified *W. magnus* with the genotype, *W. perrini*, but the example here listed is certainly distinct, even if its inner whorls might be confused with such immature *Wasatchites* as were figured by Mathews as *Kashmirites*, e. g. *K. thornei* (1929, p. 38, pl. vi, figs. 22-25).

HORIZON AND LOCALITIES. Upper Eo-trias, Upper Owenitan, *Anasibirites* Beds. Fort Douglas Military Reservation, Utah, U.S.A.

SPECIMENS :

C. 36153.

C. A. Matley Coll., 1930.

Wasatchites magnus, Mathews.

1929, p. 41, pl. xi, figs. 1, 2 ; J. P. Smith, 1932, p. 67 (*Kashmirites perrini*).

DIAGNOSIS. *Wasatchites* with more compressed and higher whorls at the same diameter than *W. perrini* or *W. tridentinus*, and more robust ornamentation than *W. meeki*.

MEASUREMENTS :

Holotype (Mathews)	. 114	. 44	. 26	. 29
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REMARKS. As mentioned in the description of *W. meeki*, the material in the Collection is insufficient to prove the specific distinctness of the present form, but I follow Mathews's interpretation, rather than J. P. Smith's, whose misreading of the affinities of *Kashmirites* was commented upon on p. 351.

HORIZON AND LOCALITIES. Upper Eo-trias, Upper Owenitan, *Anasibirites* Beds. Fort Douglas Military Reservation, Utah, U.S.A.

SPECIMENS :

C. 36151-2.

C. A. Matley Coll., 1930.

Genus **KEYSERLINGITES**, Hyatt.

1900, p. 559 = "*Robustites*", Philippi, 1901, p. 89.

GENOTYPE. *Ceratites subrobustus*, Mojsisovics, 1886, p. 44 (= *Ceratites middendorffi*, Keyserling (*partim*), 1845, pl. ii, fig. 4 only).

DIAGNOSIS. More-or-less evolute, often inflated, Sibiritidæ, with prominent inner tubercles, arising from an *Anasibirites*-like costation. Ribs in some forms continuous across a broad, subtabulate periphery, in others reduced to rows of small

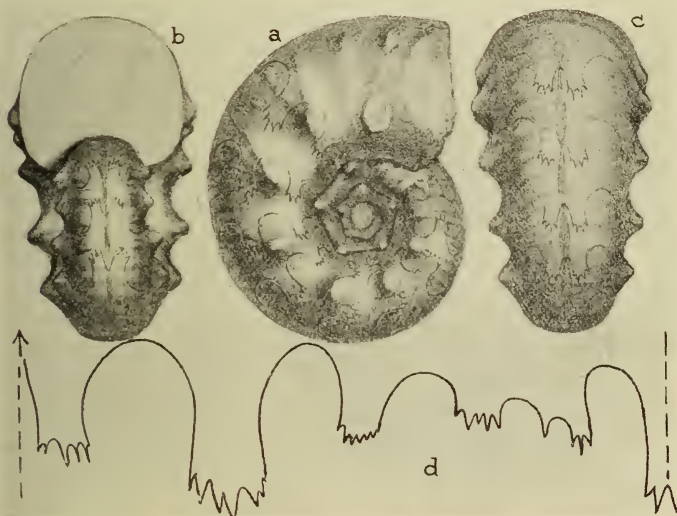


FIG. 119.—a-c, *Keyserlingites subrobustus*, Mojsisovics. Side- and two peripheral views of a small example (reduced to $\frac{1}{5}$ linear). d, Complete suture-line of *K. middendorffi* (Keyserling) (reduced to $\frac{4}{5}$ linear). Lower Trias. Mouth of Olenek River, Siberia. (After Mojsisovics, 1886, pl. vi, figs. 1a-c, and pl. xx, fig. 10.)

tubercles at the ventro-lateral edges. Suture-line ceratitic, with large external saddle, as in Stephanitids (fig. 119d).

DISTRIBUTION. Upper Eo-trias. Spitsbergen; Siberia.

REMARKS. Diener has repeatedly directed attention to the difficulties connected with the elucidation of the affinities of *Keyserlingites*; but after demonstrating that his Himalayan forms (*Durgaites*) had no connection with the Arctic species, he yet decided to leave them in the same genus. Apart from the impossibility of accepting *Durgaites* (p. 356) as a sub-genus of

Keyserlingites, it seems to the writer that Diener (1915a, p. 179) was wrong in including in the restricted *Keyserlingites* (after Mojsisovics) *Ceratites vega*, Oeberg, and *C. bungei*, Mojsisovics. The former (refigured in Mojsisovics, 1886, pl. ii, fig. 15), interpreted by means of a specimen (from the "Oil Shales", Disco Bay, Edge Island) of a less poorly preserved, allied form from Spitsbergen, may be a *Ceratites* or *Gymnotoceras*. *Ceratites bungei* differs from *Olenikites* merely in its ceratitic suture-line and larger size, and may well be taken to prove that *Olenikites* is a degenerate offshoot of the *Keyserlingites* stock.

No doubt these stocks are all closely related, and not only are the difficulties, to which Philippi (1901, p. 100) drew attention, largely nomenclatorial, but even the difference between *Keyserlingites* and *Durgaites* is not so fundamental as appears from their being considered (for purely systematic purposes) as two distinct genera. Diener has shown that they differ widely in ontogeny, but the days are past when it was comfortably assumed that in order to trace ammonite genealogy it was only necessary to follow out the "law" of earlier inheritance. The young of a highly ornamented species may be so variable that a mechanical application of this as of other "laws", still in vogue, would yield the most ridiculous results, "proving" widely different ancestry for the members of one species.

The Spitsbergen form here described as *Wasatchites tridentinus* differs from *K. middendorffi* (Keyserling) merely in its simpler external lobe and its *Anasibirites*-like inner whorls. These are somewhat intermediate between *A. spiniger* and *A. robustus*, v. Krafft (in v. Krafft and Diener, 1909, pl. xxxi, figs. 2, 1); but in the supposedly slightly later Olenek species of *Keyserlingites*, even the innermost whorls are highly tuberculated. The resemblance to *Stephanites* is striking, but the occurrence of forms (discussed below) in Kashmir, Timor and Armenia, which connect *Stephanites* with different radicals, makes it desirable to exclude *Keyserlingites* from the Stephanitidæ.

Genus DURGAITES, Diener.

1905b, p. 788.

GENOTYPE. *Keyserlingites dieneri*, Mojsisovics, 1903, p. 328 = *Ceratites subrobustus*, Diener, *non* Mojsisovics, 1895b, p. 20, pl. xvi.

DIAGNOSIS. Rather evolute, inflated Sibiritidæ with coronate inner whorls and tendency to develop outer (periphero-lateral) tubercles after the shifting of the principal spines to below the

middle of the whorl-side. Having broadly arched, sometimes subtabulate, periphery with transverse ribs. Suture-line ceratitic, with large external saddle as in *Stephanites*.

DISTRIBUTION. Lower Meso-trias, Beyrichitan. Himalayas; Timor.

REMARKS. Diener left *Durgaites* as a sub-genus of *Keyserlingites*, but the discovery of an advanced *Durgaites* in Timor, and of a primitive "*Keyserlingites*" in Spitsbergen, has still

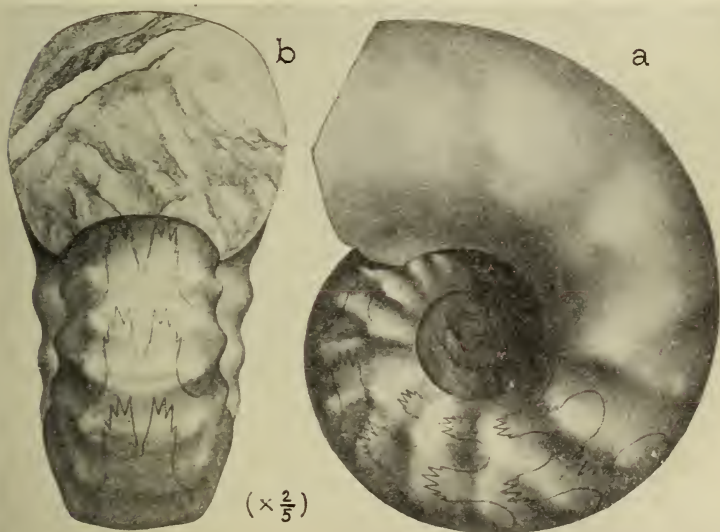


FIG. 120.—*Durgaites dieneri* (Mojsisovics). Side- and peripheral views (reduced to $\frac{2}{5}$ linear) of holotype from Lower Meso-trias, Shalshal Cliff, Himalayas. (After Diener, 1897, pl. xvi = "*Ceratites subrobustus*, Mojsisovics".)

further enhanced the considerable gulf that Diener himself found to exist between the two stocks. The internal elements of the suture-line of *D. angustecostatus*, Welter sp. (1915, p. 108, pl. lxxxvii, figs. 2, 3) show that Philippi (1901, p. 89) was right in separating the "subrobusti" from the "nodosi". In placing *Durgaites* with Sibiritidæ, I am guided by the fact that the inner whorls of *D. dieneri* have been mistaken by v. Krafft and Hayden for "*Sibirites*" *prahlada*, and that Diener (1905a, p. 685) considered them, apart from the ribbing of the ventral area, to show most resemblance in shape and ornamentation to

Tirolites. The genus *Durgaites* may not be a direct derivative of the groups discussed above, but it certainly seems closely allied to these Sibiritids and to *Keyserlingites*, although in this the lateral position of the principal tubercles on the outer whorl results from the outward movement of the original umbilical (*Anasibiritid*) bullæ.

In connection with *Durgaites*, it is necessary to discuss the Timor "*Tirolites*" *meridianus*, Welter, here refigured (fig. 121). In 1930 (p. 83) I created for it the new genus *Anastephanites*, taking it to be of Lower Triassic age; but I am now inclined to believe that J. P. Smith (1932, p. 19) was right in considering

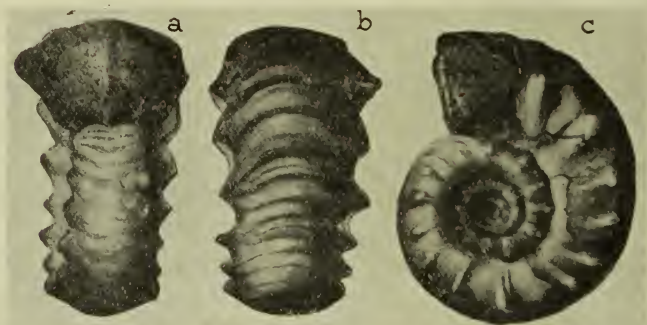


FIG. 121.—*Durgaites*? (*Anastephanites*) *meridianus* (Welter). Side- and two peripheral views of unique holotype. Trias (Lower?). Bihati, Timor. (After Welter, 1922, pl. clxviii, figs. 14–16, as "*Tirolites*".)

"*Tirolites*" *meridianus* to be probably identical with "*Sibirites*" *prahlada*, Diener (1895*b*, p. 37, pl. vii, figs. 5*a*–*d*), *i. e.* it seems to represent merely the inner whorls of a *Durgaites*, although in the Lower Anisian forms, such as the Timor examples described below, the ventral tubercles are already developed at a small diameter.

Welter considered that his unique Timor form could not be brought into closer comparison with any of the known species of *Tirolites* from Dalmatia or Albania; yet, in spite of the obvious differences in the suture-line and other characters, he included it in the group of *T. spinosus* [Mojsisovics], Kittl. Two ceratitic lobes have been found in some *Tirolites* (*T. toulai*, Kittl), and the position of the tubercle also corresponds with that of L, as in "*T.*" *meridianus*, whilst the larger size of the

external saddle in proportion to the other elements of the suture-line could perhaps be explained by the increased ventral area in the form here discussed. On the other hand, the subdivision of the lobes is reminiscent of that found in other stocks, from Columbites to Sibiritids, and in the true *Tirolites* there is neither the coarsely ribbed periphery nor the regular tuberculation found in "*T.*" *meridianus*.

The Californian *Tirolites pacificus*, Hyatt and Smith (1905, p. 159, pl. xxi, figs. 14-18), from the *Parapopanoceras* Beds, was doubtfully included by Frech (1908, pl. lxiv) in *Stephanites*. Like the Himalayan "*Sibirites*" *prahlada*, the suture-line of which is figured in fig. 96e (p. 276), and "*Ceratites*" sp. ind. aff. *C. middendorffi*, non Keyserling (Diener, 1895b, p. 28, pl. v, figs. 7a, b, listed as *Keyserlingites* [*Durgaites*] in 1915a, p. 179), *T. pacificus* is probably also referable to *Durgaites*, in spite of differences in the suture-lines.

***Durgaites angustecostatus* (Welter).**

1915, p. 108, pl. lxxxvii, figs. 2, 3 (*Keyserlingites*); Kutassy, 1933, p. 509.

DIAGNOSIS. Subplatygyral, subangustumbilicate to sublatumbilicate *Durgaites*, with second lateral and auxiliary elements smaller than in *D. dieneri*, but saddles more contracted at base and first lateral lobe more spreading.

MEASUREMENTS :

Welter, p. 109 . . .	90 . . .	.44 . . .	.57 . . .	.31
C. 34112	56 . . .	.40 . . .	.60 . . .	.35
C. 34111	120 . . .	.45 . . .	.58 . . .	.33

REMARKS. Welter thought the suture-lines of *D. dieneri*, the genotype, and of *D. angustecostatus* to be totally different; but these differences are only specific. The nine examples in the collection differ slightly among themselves, and in a particularly coarse variety (C. 34108) the very prominent lateral spines may be high up on the whorl-side already at the diameter of the holotype (90 mm.), while at 110 mm. diameter the thickness in this coarse variety amounts to 73%. It differs from the more closely-tuberculate typical forms already at 12 mm. diameter.

HORIZON AND LOCALITIES. Lower Anisian, beds with *Sturia mongolica*, Timor. (Three fragments in the Collection (C. 37209a-c) were embedded in the large block with *Gymnites* and *Leiorhyllites*, etc., that also yielded *Parasageceras*.)

SPECIMENS :

C. 34108-14. Nifoekoko, Timor. *M. E. Walsh Coll.*, 1930.

C. 37204-5, 37209a-c. Toeboelopo, Timor.

M. E. Walsh Coll., 1930.

INCERTÆ SEDIS.

? Genus **OLENIKITES**, Hyatt.

1900, p. 559.

GENOTYPE. *Dinarites spiniplicatus*, Mojsisovics, 1886, p. 10, pl. i, figs. 1a-c.

DIAGNOSIS. Micromorph forms, probably Sibiritidæ, with typically entire "Dinaritid" suture-line and generally only one lateral lobe; strong umbilical tubercles on the septate part, tending to disappear on the body-chamber (Pl. VII, fig. 3) or earlier (in some "obsoleti" ?).

DISTRIBUTION. Upper Eo-trias, Columbitan ?. Siberia; (Salt Range ?).¹

REMARKS. Diener (1915a, p. 211) left *Olenikites* with the group of the "circumplicati" in *Dinarites*; but *Diaplococeras circumplicatum* (Mojsisovics), referred to on p. 379, belongs to a different stock, characterized by the acquisition of external tubercles and by much larger size. *Olenikites* seems connected with the true *Dinarites* by its suture-line, and with *Arctoceras* by the form figured by Mojsisovics (1886, pl. ix, figs. 19a, b, non c) as *Dinarites levis*, and by the immature Spitsbergen forms previously (Spath, 1921, p. 299) recorded. On the other hand, *Ceratites sigmatoideus*, Mojsisovics (1886, p. 24, pl. ii, fig. 10), and *Ceratites nikitini*, Mojsisovics (1888, p. 6, pl. i, figs. 12, 13), have ceratitic suture-lines, which suggests that the "Dinaritid" entire lobes of the more typical *Olenikites* may be due merely to reduction of an originally ceratitic suture-line. The resemblance to *Dinarites* and *Tirolites*, with entirely different ornamentation, would thus be only superficial; and instead of considering, with Mojsisovics and Diener (1905b, p. 783), that *Keyserlingites* is a development of *Olenikites*, I consider the latter to represent a simplified offshoot of the Sibiritid stock which also produced *Keyserlingites*.

The Arctic "Ceratites obsoleti", which, according to Mojsisovics, are descendants of the "spiniplicati", may be more

¹ See "*Dinarites*" *dimorphus*, Waagen, 1895, p. 25, pl. viia, figs. 8, 9.

closely connected with the Arctoceratidæ (*Czekanowskites*), but their relationship to *Preflorianites* and *Xenoceltites*, described above, is as yet to be determined.

Olenikites spiniplicatus (Mojsisovics).

Plate VII, fig. 3.

1886, p. 10, pl. i, fig. 1 (*Dinarites*).

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate to sublatumbilicate *Olenikites*. Whorl-section elliptical, with arched venter and rounded sides. Inner whorls with distant and prominent spines on a high and rounded umbilical edge, degenerating on body-chamber. Suture-line with one pointed, rounded, or ceratitic, lateral lobe.

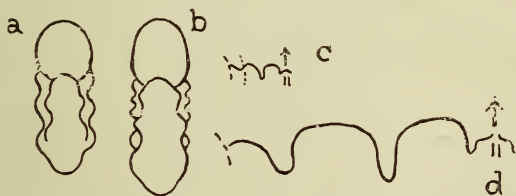


FIG. 122.—*Olenikites spiniplicatus* (Mojsisovics). *a-c*, Diagrammatic outline sections and suture-line, adapted from Mojsisovics, 1886, pl. i, figs. 1-18. *d*, External suture-line of the example (B.M., C. 513) figured in Pl. VII, fig. 3 (enlarged $\times 5$) from the Upper Eo-trias, mouth of the Olenek River, Northern Siberia.

MEASUREMENTS :

Mojsisovics, p. 14, No. I	. 20	. .40	. .35	. .28
„ „ III	. 23	. .39	. .35	. .35
C. 513 (Pl. VII, fig. 3)	. 22	. .39	. .36	. .32

REMARKS. This is an exceedingly variable species, and Mojsisovics pointed out that the variability was shown even in the suture-lines, “ordinarily the most constant characteristic”. It is probable, however, that with less abundant material a number of species would have been created. The differences in whorl-section, width of the umbilicus and number of tubercles (*e.g.* var. *multiplicata*) are not important, but if, in one and the same species, the suture-line may vary from a goniatitic type, with pointed L, to a dinaritid, and even toothed, ceratitic type, then it is clear that a rigid classification of ammonites

according to suture-lines is as impossible as the separation into a distinct family of the keeled offshoots of Dinaritids and Tirolitids.

HORIZON AND LOCALITIES. Upper Eo-trias, Prohungaritan ?. Siberia.

SPECIMENS :

C. 513. Mouth of Olenek River.

Dr. F. Schmidt (ex Czekanowski) Coll., 1884.

(This is the example referred to in Spath, 1921, p. 299.)

c. Family STEPHANITIDÆ, Arthaber emend.

1896, p. 75 (as sub-family of the Tropitidæ).

DIAGNOSIS. More-or-less evolute, coronate shells, with broadly arched venters, lateral tubercles, and simple, ceratitic suture-line, generally with large, external saddle.

REMARKS. The genus *Stephanites*, Waagen, so far incompletely known, has been included by some authors in the Ceratitidæ, and by others in the Sibiritidæ. Hyatt (1900, p. 558) considered the latter family to belong to his Ceratitida, but J. P. Smith in 1913 (p. 639) transferred the Sibiritinæ again to the family Tropitidæ. He listed in it the three genera *Acrochordiceras*, *Stephanites* and *Sibirites*, and these also figure in Arthaber's later scheme (1911, p. 179) as a family Acrochordiceratidæ, of the phylum Gastriocerata.

Considering that *Stephanites* weakens its tuberculation on the body-chamber (like *Parastephanites atavus*, from which Waagen thought it was derived) and that the suture-lines of the forms of Waagen's group of *Acrochordiceras damesi* (*non* Noetling) are unknown (and almost certainly not at all like the complex lobe-line of *A. hyatti*, Meek, the genotype) it seems preferable to separate the Stephanitidæ from Acrochordiceratidæ. The writer would also provisionally attach to the former the very peculiar, but as yet incompletely-known genus *Paratirolites*, Stojanow, some forms of which were indeed described as *Stephanites*. In the Djulfa area the association of this last group with "*Xenodiscus*"-like forms makes it probable that, like Kashmiritidæ and others, they had their origin in that primitive evolute stock that also produced the simplified Tirolitids. Their connection, however, with the Sibiritidæ is more indirect.

Genus **STEPHANITES**, Waagen.

1895, p. 100 ; Diener, 1915a, p. 267.

GENOTYPE. *Stephanites superbus*, Waagen, 1895, p. 101, pl. ii.

DIAGNOSIS. Rather evolute, inflated Stephanitidæ, with depressed, coronate inner whorls, and more rounded body-chamber, with broadly arched periphery. Suture-line (fig. 96c, p. 269) ceratitic, with large external saddle and only two lobes.

DISTRIBUTION. Upper Eo-trias, Stephanitan. Salt Range ; Kashmir, Armenia.

REMARKS. Frech (1905, pl. xxviii) included *Keyserlingites subrobustus* and *K. middendorffi* doubtfully in the genus *Stephanites*, and figured a Salt Range example of *S. superbus*, which, indeed, has a suture-line almost identical with that of *Keyserlingites*. *Stephanites*, however, is associated in the Upper Ceratite Limestone with *Anasibirites* and *Prionites*, so that the resemblance to the presumably late Eo-triassic *Keyserlingites*, while great enough to justify the placing of the Stephanitidæ close to the Sibiritidæ, must not be over-rated. *Acrochordiceras distractum*, Waagen (1895, p. 94, pl. iii, fig. 4), is probably also a *Stephanites*, although its suture-line is unknown. It shows some resemblance to the forms discussed above (p. 356) under *Durgaites*, but it will be seen that there is no tendency to develop outer tubercles in the Stephanitidæ.

Genus **PARASTEPHANITES**, Hyatt.

1900, p. 558 ; Strand, 1929, p. 5 ("*Acrochordiceroïdes*"); Spath ('Naturalist', 1929), p. 271.

GENOTYPE. *Acrochordiceras atavum*, Waagen, 1895, p. 91, pl. iii, figs. 2a, b.

DIAGNOSIS. Rather evolute, discoidal Stephanitidæ, with (apparently) coronate inner whorls, as in "*Anastephanites*", but with a tendency to lose the primary bullæ and secondary ribs on the body-chamber. Venter narrowly arched. Suture-line incompletely known, with only two lateral lobes, of which the inner (auxiliary lobe) is entire.

DISTRIBUTION. Upper Eo-trias ? Salt Range.

REMARKS. Diener (1905b, p. 766) stated that Waagen's work on the ammonites of the Ceratite Beds of the Salt Range had met with such decided opposition from various sides that reference to this memoir could scarcely be made without

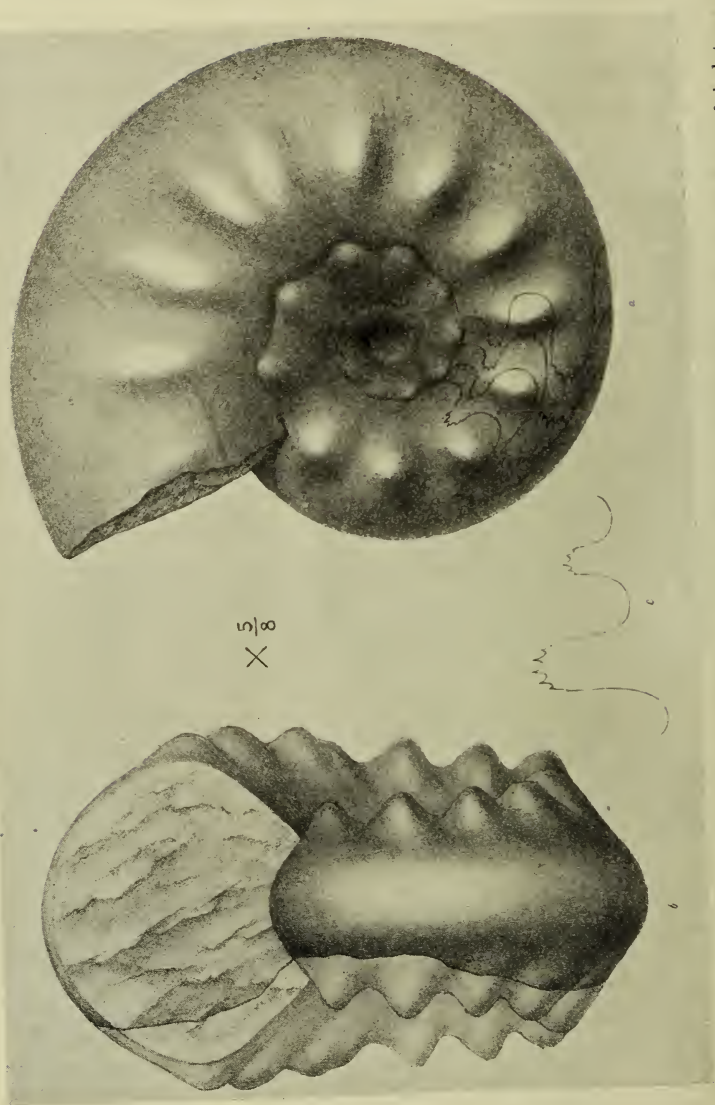


FIG. 123.—*Stephanites superbis*, Waagen. Side- and peripheral views and part of suture-line of holotype (reduced to $\frac{5}{8}$ linear) from the Lower Trias, Upper Ceratite Limestone. Chidroo, Salt Range. (After Waagen, 1895, pl. ii, figs. a-c.)

encountering objection. No doubt many of Waagen's types were poorly preserved; and, as I had occasion to point out (1927*a*, p. 1) in the 'Revision of the Jurassic Cephalopoda of Kachh (Cutch)', his figures were often restored, not always successfully. Yet in so far as *P. atavus* is concerned, it appears that Waagen may have been wrong only in the dating, and I

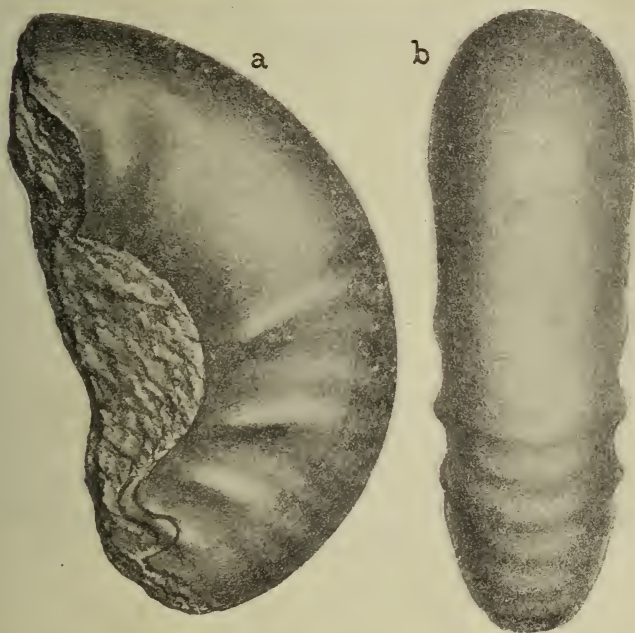


FIG. 124.—*Parastephanites atavus* (Waagen). Side- and peripheral views of holotype body-chamber fragment. Lower Trias, Ceratite Sandstone. Virgal, Salt Range. (After Waagen, 1895, pl. iii, figs. 2*a*, *b*.)

believe that Hyatt was justified in separating generically even such a doubtful fragment of body-chamber as that of *P. atavus*. The form clearly cannot be included either in *Stephanites* or in *Acrochordiceras*, and since Waagen associated with it the sub-carinate *A. dimidiatum*, Waagen (1895, p. 93, pl. iii, figs. 3*a*, *b*), in what (obviously with some reason) he called a well-characterized developmental series, we may well accept *Parastephanites*, even if, like many other genera, it is as yet

incompletely known. Diener (1915*a*, p. 254) listed *P. alarus* doubtfully as a *Sibirites*, but there is no resemblance whatever to the typical Siberian forms of this genus, and even *Anasibirites* has an entirely different suture-line.

INCERTÆ SEDIS.

? Genus **PARATIROLITES**, Stoyanow.

1910, p. 75 ; Diener, 1915*a*, p. 368 (*Xenodiscus*).

GENOTYPE. *Paratirolites kittli*, Stoyanow, 1910, p. 82, pl. ix, figs. 1 (lectotype), 2.



FIG. 125.—*a-d*, *Paratirolites kittli*, Stoyanow. Side- and two peripheral views and suture-line of lectotype and worn suture-line (*e*) of *P. dieneri*, Stoyanow. (After Stoyanow, 1910, pl. ix, figs. 1*a-d*, and pl. viii, fig. 2*c* [*partim*].)

DIAGNOSIS. Evolute ? Stephanitidæ with coarse distant ribs, pronounced tubercles at latero-ventral edge, and broadly-arched venter. Suture-line with large external saddle, small lateral saddle, and large auxiliary saddle.

DISTRIBUTION. Upper Eo-trias, Columbitan ?. Armenia ; Persia.

REMARKS. *Paratirolites* was probably correctly interpreted as a development close to *Anakashmirites nivalis* (Diener), and transitional forms are known, like some of Stoyanow's "*Xenodiscus*". On the other hand, the example described and

figured by this author as *Stephanites* (?) *waageni* (p. 89, pl. viii, fig. 3) must also be referred to *Paratirolites* on account of its small lateral saddle; but it is associated with a form of *Stephanites* (Stoyanow's pl. vii, fig. 8) that cannot, in the absence of the suture-line, be separated from the typical Salt Range forms.

Stoyanow pointed out the similarity of his *Paratirolites dieneri* (pl. viii, figs. 2a-c) to the true *Tirolites*; but since the peculiarities of suture to which he refers (see fig. 125e) are largely due to weathering, they are obviously of no use for elucidating the genesis of the *Tirolites* suture-line. Again, the constancy in the distribution of the ribs, to which Stoyanow directed attention, would be scarcely sufficient, by itself, for separation of *P. dieneri* from the true *Tirolites*; but it is here believed that they are derived from the same root-stock.

D. Family TIROLITIDÆ, Mojsisovics emend.

1882, p. 64 (as sub-family of the Ceratitidæ).

DIAGNOSIS. Evolute shells with feebly ceratitic or entire suture-lines, but generally more-or-less prominent lateral tubercles, often already at an early stage.

REMARKS. The Tirolitidæ have always been taken to be connected with Dinaritidæ by transitions, but they are at most a parallel development, and certainly not descendants of the Dinaritidæ. The family is now taken to include the genera *Tirolites*, Mojsisovics, *Tirolitoides*, nov. (= *Paraceratites*, Kittl non Hyatt); ? *Diaplococeras*, Hyatt (= *Liccaites*, Kittl), *Svilajites*, and *Bittnerites*, Kittl. Whether *Dorikranites*, Hyatt (= *Bogdoites*, Kittl), should be considered a keeled offshoot of Tirolitidæ is altogether doubtful. *Dorikranites* is thus doubtfully attached to the present family, merely on the authority of Mojsisovics.

Paratirolites, which has been considered by its author to be the direct descendant of *Anakashmirites*, occurs with *Stephanites*, and is thus probably of Upper Owenitan age. If the Tirolitidæ are its reduced derivatives, as seems probable, the earlier Stephanitidæ are rather distinct. The minute *T. ultimus*, Mojsisovics, and the Carnian *Metatirolites*, Hyatt and Smith (fam. Tropitidæ), are here considered to be entirely unrelated to the true *Tirolites*.

Genus **TIROLITES**, Mojsisovics.

1879, p. 138 ; 1882, p. 64.

GENOTYPE. *Ceratites idrianus*, Hauer (1865, p. 610, pl. i, figs. 4, 5), Mojsisovics, 1882, pl. i, fig. 1.

DIAGNOSIS. Evolute Tirolitidæ with generally compressed, rectangular whorls, broadly rounded or tabulate venter, and tuberculation at the ventro-lateral edges, often also costation at the sides. Suture-line simple, with broad and shallow, entire or feebly toothed L, and auxiliary lobe on the umbilical slope.



FIG. 126.—*Tirolites cassianus* (Quenstedt). *a*, *b*, Side- and peripheral views of a Campile example. (After Arthaber, in Frech, 'Lethæa Geognostica', 1905, pl. xxxiv, figs. 15*a*, *b*.) *c*, Last suture-line of a large example of the var. *tenuis* from Cencenighe. (After Mojsisovics, 1882, pl. ii, fig. 4.)

DISTRIBUTION. Upper Eo-trias, Columbitan. Alps ; Balkans ; Astrakhan ; Himalayas ; Idaho ?.

The record from Madagascar (Merle and Fournier, 1911, p. 664) is as yet unconfirmed.

REMARKS. Most of the numerous so-called species listed below are very closely allied ; and, as is the case with tuberculate or highly ornamented ammonites in general, unless we allow for considerable individual variation, instead of describing species we merely name specimens. Kittl's many specific names, however, are here retained, since there are only about forty examples in the Collection—a number far too small to show which of the "species" are well founded.

The first six species have been grouped in a division "Spinosi" and the remainder in "Seminudi" (with non-tuberculate inner whorls), but there are many transitions between the two groups, also passage forms to the other genera discussed below, of which, however, only *Dorikranites* is represented in the Collection.

Tirolites cassianus (Quenstedt).

Fig. 126.

1849, p. 231, pl. xviii, fig. 11 (*Ceratites*); Diener, 1915a, p. 278;
M. M. Ogilvie Gordon, 1927 (ii), p. 31, pl. iii, fig. 39.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Tirolites*, with whorls slowly increasing, first rounded and smooth, later polygonal and reticostate. With broad, rounded venter, having tubercles on the lateral edges, at first distant, then closer, and degenerating at the end. Suture-line with lateral lobe faintly toothed, and bifid external lobe only present in large examples.

MEASUREMENTS :

Kittl, 1903, p. 55 (pl. ix, fig. 6)	. 43	.34	.27	.45
<i>Ibid.</i> , var. <i>a</i> (pl. ix, fig. 5)	. 42	.34	.22	.44

REMARKS. Mojsisovics (1882, p. 70) stated that the ornament showed weakening on the body-chamber, accompanied by increase in the number of spines and ribs. On the final whorls of larger examples there are 13-16 tuberculate ribs; the next inner whorls have only 8-9. According to Kittl the peristome has two narrow lateral lappets and a broad ventral lappet, as in other species of *Tirolites*.

The var. *tenuis* of Mojsisovics has the ribs more curved than the typical form, and on the body-chamber there is no alternation of stronger and weaker ribs. This, however, is a very variable character and, like the degeneration of the ornament on the body-chamber, found in all the species of *Tirolites*.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan (Upper Werfen = Campile Beds). S. Alps; Dalmatia; Astrakhan.

SPECIMENS :

83003c, d. Irscharei, Campile Mts. *Klipstein Coll.*, 1851.

83003a (?). An indeterminable (worn) specimen from same locality and collection, labelled "*Ceratites nodosus*".

C. 30659 (?). St. Cassian, Tyrol.

D. Sharpe Coll., presented *Geol. Soc.*, 1911.

Tirolites angustilobatus, Kittl.

1903, p. 54, pl. viii, fig. 19 ; pl. ix, figs. 1-3.

DIAGNOSIS. Like *T. cassianus*, but with long and narrow lateral lobe.

MEASUREMENTS :

Kittl, p. 54, pl. ix, fig. 3 (holotype)	47·5	·35	·25	·43
<i>Ibid.</i> , pl. viii, fig. 19 (var. <i>alpha</i>)	42	·33	·25	·44

REMARKS. Kittl distinguished a var. *alpha* without denticulations of the lobes ; and the two examples in the Collection apparently belong to this variety. Both this variety, however, and the typical form may be only extreme forms of *T. cassianus*, and, as Kittl pointed out, the var. *alpha* of the last species is also connected with the form here described by the slight development of the tuberculation.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan. Dalmatia.

SPECIMENS :

C. 23152-3. Mué, Dalmatia.

Nat. Hist. Museum, Vienna, 1922.

Tirolites spinosus, Mojsisovics.

1882, p. 70, pl. i, fig. 10 ; pl. ii, figs. 1-3 ; Diener, 1915a, p. 279.

DIAGNOSIS. Like *T. cassianus*, but with fewer tubercles and ribs on outer whorl.

MEASUREMENTS :

Kittl (1903, p. 56, pl. ix, fig. 7)	54·7	·35	·25	·42
-------------------------------------	------	-----	-----	-----

REMARKS. This species is connected by transitions with *Tirolites cassianus*, and Kittl may have been right in questioning whether they can be separated specifically. Since, however, others of his own numerous species of *Tirolites* are no less close to Quenstedt's form than *T. spinosus*, Mojsisovics's species is here accepted. The number of ribs on the body-chamber is only about 10. The closely allied *T. haueri*, Mojsisovics, has ribs that do not reach to the umbilical suture, and has especially a broader venter ; in *T. robustus*, Kittl, which resembles the inner whorls of the form here described, the suture-line is entire throughout.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan (Upper Werfen = Campile Beds). S. Alps ; Dalmatia.

SPECIMENS :

- 83003b. Irscharei, Campile Mountains. *Klipstein Coll.*, 1851.
 C. 23177-9. Muć, Dalmatia. *Nat. Hist. Museum, Vienna*, 1922.
 C. 1476. St. Cassian. *J. E. Lee Coll.*, 1885.

Tirolites haueri, Mojsisovics.

1882, p. 71, pl. iii, figs. 2-4 ; Diener, 1915a, p. 278.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Tirolites*. Whorl-section with wider ventral area than in previous two species ; number of tubercles and ribs as in *T. cassianus*, but more prominent, as in *T. spinosus*. Suture-line as in *T. spinosus*, with external saddle entirely on venter.

MEASUREMENTS :

Kittl, 1903, p. 57 (pl. ix, fig. 8)	.	49	·30	·30	·45
„ „ „ („ „ 12)	.	52·5	·34	·32	·41
„ „ „ („ „ 13)	.	52·3	·34	·34	·42

REMARKS. This species is closely allied to the two forms already described, and may be merely a variety of *T. spinosus*. As Kittl pointed out, the fact that the ribs in *T. haueri* do not attain the umbilical suture is not a sufficient distinction, since the rim is always smooth, and the gradual dying-out of the costæ towards the umbilicus is very variable even in the same individual. Another closely related form is *T. turgidus*, Mojsisovics, with still wider ventral area and a larger number of tubercles and ribs, especially on the outer whorls.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan (Upper Werfen = Campile Beds). S. Alps ; Dalmatia.

SPECIMENS :

- C. 23159-62. Muć, Dalmatia. *Nat. Hist. Museum, Vienna*, 1922.
 C. 27919-20. ? 27921-2. Goransko, Montenegro. *V. Hawelka Coll.*, 1926.

Tirolites turgidus, Mojsisovics.

1882, p. 72, pl. iii, figs. 6-7 ; Diener, 1915a, p. 280.

DIAGNOSIS. Like *T. haueri*, but with wider venter and closer ribs and tubercles.

MEASUREMENTS :

Kittl, 1903, p. 60 (pl. x, fig. 7)	.	63·3	·33	·41	·48
„ „ („ „ 8)	.	56·7	·35	·35	·46

REMARKS. The whorls in this form are wider than high, and the ribbing is said to be more regular than in the somewhat similar, but less inflated, *T. haueri*. There are, however, transitions to this species. *T. darwini*, described below, is another closely allied form, but is also less depressed, and loses its tuberculation on the outer whorl.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan (Upper Werfen = Campile Beds). S. Alps; Dalmatia.

SPECIMENS :

C. 23180-3. Gornje Muć, Dalmatia.

Nat. Hist. Museum, Vienna, 1922.

Tirolites darwini, Mojsisovics.

1882, p. 73, pl. ii, fig. 13; pl. iii, fig. 1; Diener, 1915a, p. 278.

DIAGNOSIS. Like the previously described forms of *Tirolites*, but more evolute, and with the tubercles disappearing on the outer whorls. Suture-line with distinct second lateral (umbilical) lobe.

MEASUREMENTS :

Kittl, 1903, p. 62 (pl. xi, fig. 1)	.	64·4	·35	·28	·44
„ „ „ (pl. x, fig. 11)	.	85·2	·36	·25	·42

REMARKS. Kittl distinguished five varieties within this species, namely, (1) the var. *cinctus*, with resemblance in ornamentation to *T. illyricus* and *T. repulsus*; (2) var. *reminiscens*, with alternating, irregular groups of strong and weak ribs on the outer whorls; (3) var. *modestus*, with merely faint costation after the early spinose stage; (4) var. *costatus*, with regular, strong, radial ribs on the outer volution; (5) var. *abbrevians*, with scarcely any non-tuberculate ribs between the spinose stage and the almost entirely unornamented body-chamber portion. These varieties were all represented by large numbers of examples, and Kittl suggested that Auerbach's *Ceratites smiriagini* (1871, p. 50, pl. iv, figs. 9-11) also was only a specialized variety of *T. darwini*. Since the former name is the older, it would have to be adopted in place of *T. darwini* if a wider interpretation of these "species" were adopted. The only available example in the Collection differs from

Mojsisovics's figure of *T. smiriagini* (1882, p. 73, pl. lxxxi, fig. 1) merely in having a wider periphery.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan (Upper Werfen = Campile Beds). S. Alps; Dalmatia.

SPECIMENS :

C. 23156. Muć, Dalmatia. *Nat. Hist. Museum, Vienna, 1922.*

Tirolites kernerii, Kittl.

1903, p. 64, pl. xi, fig. 8.

DIAGNOSIS. Like *T. spinosus* and *T. haueri*, but with a second lateral saddle at the umbilical suture, and more distinct tothing of the lobes.

MEASUREMENTS :

Kittl's holotype . . .	49	. . .	34	. . .	27	. . .	41
C. 23166 . . .	44	. . .	36	. . .	32	. . .	41

REMARKS. The holotype must be assumed to be in a better state of preservation than the two examples in the Collection, for the differences of these from the allied "species" are inappreciable. The suture-line of the (unique) type may be more advanced than that of such forms as *T. spinosus*, but we know from the study of Cretaceous Pseudoceratites that this feature is as variable as any of the other characters in ammonites, and that differences such as those mentioned in the above diagnosis are scarcely sufficient for the separation even of varieties. Several of the other "species" of *Tirolites* here listed, however, are as narrowly interpreted.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan (Upper Werfen = Campile Beds). S. Alps; Dalmatia.

SPECIMENS :

C. 23166-7. Muć, Dalmatia.

Nat. Hist. Museum, Vienna, 1922.

Tirolites illyricus, Mojsisovics.

1882, p. 68, pl. ii, fig. 10; Diener, 1915a, p. 278.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Tirolites*. Whorl-section quadrate, with flattened venter; ribbing irregular; about ten ventro-lateral spines on the outer whorl; inner whorls non-tuberculate. Suture-line with entire, narrow, lateral lobe, typically at the position of the tubercles, and wide lateral saddle across the whole of the sides.

MEASUREMENTS :

Kittl, 1903, p. 49 (pl. viii, fig. 4)	48·5	·34	·25	·43
„ „ „ („ „ 6)	37·5	·34	·30	·40

REMARKS. Kittl pointed out that there was great variability in the position of the lateral lobe, as well as in ornamentation and whorl-section, and that among his abundant material there was not a single individual that was identical with the unique (and extreme) holotype. Both Mojsisovics and Kittl included this species in the group of “Seminudi”, characterized by having non-tuberculate inner whorls, unlike all the species described above.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan (Upper Werfen = Campile Beds). S. Alps; Dalmatia; Albania.

SPECIMENS :

C. 23163-5. Muć, Dalmatia.

Nat. Hist. Museum, Vienna, 1922.

Tirolites rectangularis, Mojsisovics.

1882, p. 69, pl. iii, fig. 5.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Tirolites*. Whorl-section quadrate, with flattened venter and marginal spines, degenerating on the last half-whorl. Suture-line entire, with marginal lateral lobe and wide lateral saddle.

MEASUREMENTS :

Kittl, 1903, p. 52 (pl. viii, fig. 16)	. 44	·32	·23	·44
„ „ „ („ „ 17)	. 42	·35	·33	·40

REMARKS. This species, unfortunately, is represented only by two poorly preserved examples. As Kittl pointed out, there are only very few individuals that agree with the type in all characters; and it is probable that a number of quadrate-whorled forms belonging to other “species” of *Tirolites* are referred to *T. rectangularis*, including even the group of *T. cassianus*, with (typically) toothed lobes.

T. robustus, described below, has fewer spines; *T. illyricus*, similarly, is less prominently costate. *T. angustilobatus*, Kittl (1903, p. 54, pl. viii, fig. 19; pl. ix, figs. 1-3), according to its author, often differs from *T. rectangularis* merely in a more rounded whorl-section, the slight variations in the suture-line and its denticulations being of little value, even for specific separation.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan. Dalmatia; Albania.

SPECIMENS:

C. 23170-1. Muć, Dalmatia.

Nat. Hist. Museum, Vienna, 1922.

Tirolites seminudus, Mojsisovics.

1882, p. 66, pl. ii, fig. 11; Diener, 1915a, p. 279.

DIAGNOSIS. Subplatygyral, subleptogyral, sublatumbilicate *Tirolites*. With quadrate whorl-section with slightly arched venter; with 4-6 distant lateral spines, generally on the last two-thirds of the camerated portion. Inner whorls and short body-chamber smooth. Suture-line entire, with narrow lateral lobe and wide lateral saddle.

MEASUREMENTS:

Kittl, 1903, p. 41 (pl. vi, fig. 6)	.	42	·36	·26	·42
„ „ „ („ „ 8)	.	44·5	·37	·22	·36
„ „ „ („ „ 9)	.	33·9	·35	·30	·38

REMARKS. Kittl, who examined 265 examples of this species from Muć, recognized several varieties, namely, a var. *nudior*, with only 3-4 spines at a slightly earlier stage; a var. *plicosus* with indistinct folds; and transitions to *T. quenstedti* and *T. distans*. Both the last-named species, however, may be only varieties of *T. seminudus*, although Kittl, who had much more abundant material than the writer, accepted them as separate species. *T. rectangularis* and *T. illyricus*, described above, are two other species included in the "Seminudi", but they differ from *T. seminudus* itself in being more distinctly costate and multituberculate.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan. Dalmatia.

SPECIMENS:

C. 23174-6. Muć, Dalmatia.

Nat. Hist. Museum, Vienna, 1922.

Tirolites distans, Kittl.

1903, p. 42, pl. vi, figs. 12-16; pl. vii, figs. 7, 8.

DIAGNOSIS. Like *T. seminudus*, but with an isolated spine on body-chamber, typically near the mouth-border.

MEASUREMENTS :

Kittl, 1903, p. 42 (pl. vi, fig. 13)	.	40.3	.36	.32	.37
" " " (" " 15,					
lectotype)		38	.37	.30	.37

REMARKS. Kittl clearly recognized that this form was probably not specifically distinct from *T. seminudus*. It is based on an assemblage of individuals that happen to agree in one obvious character, *i. e.* the presence of an isolated spine on the body-chamber. If any other character were relied on, *e. g.* whorl-section, an entirely different grouping of the very variable individuals of *T. seminudus* (*sensu latissimo*) would have resulted. *T. illyricus*, above described, is also connected with the present form by various transitions.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan. Dalmatia.

SPECIMENS :

C. 23157 (and C. 23158 ?). Muć, Dalmatia.

Nat. Hist. Museum, Vienna, 1922.

Tirolites quenstedti, Mojsisovics.

1882, p. 66, pl. ii, fig. 12 ; Diener, 1915a, p. 279.

DIAGNOSIS. Like *T. distans* and *T. seminudus*, but larger, and therefore tuberculate to a greater diameter ; with two spines on body-chamber.

MEASUREMENTS :

Kittl, 1903, p. 43 (pl. vi, fig. 19)	.	50	.34	.21	.35
" " " (" " 20)	.	46.9	.36	.23	.40

REMARKS. The differences between this form and *T. seminudus* seem even less important than those discussed under *T. distans*. Mojsisovics's holotype, according to Kittl, was crushed, and probably only for that reason showed certain peculiarities not seen in well-preserved examples, *e. g.* a highly arched periphery and a lateral position of the spines as well as of the principal lobe. It is thus clear that this "species", like *T. distans*, should not have been separated from *T. seminudus*. If we again follow Kittl in listing it independently, it is done only because this author had the advantage of examining abundant material. On the basis of the characters above quoted he was in any case able to separate 94 examples of the present form and 74 of *T. distans* from 265 specimens of *T. seminudus*.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan. Dalmatia.

SPECIMENS :

C. 23168 (and 23169 ?). Muć, Dalmatia.

Nat. Hist. Museum, Vienna, 1922.

Tirolites robustus, Kittl.

1903, p. 43, pl. vii, figs. 9 (lectotype), 10, 11 ; pl. viii, fig. 1.

DIAGNOSIS. Like *T. quenstedti*, but with stronger spines, flatter and broader venter, and generally smaller umbilicus.

MEASUREMENTS :

Kittl, p. 44 (lectotype)	.	42·5	.	·40	.	·36	.	·34
„ (pl. vii, fig. 10)	.	45	.	·37	.	·31	.	·38

REMARKS. This species differs only slightly from *T. mercurii*, Mojsisovics (1882, p. 68, pl. i, fig. 9), with smaller umbilicus and, perhaps, a more rectangular whorl-section. Kittl distinguished a var. *cornu*, with similarly slight differences in ornamentation ; he also considered *T. dimidiatus*, based on a single deformed specimen, to represent, perhaps, merely a strongly ornamented variety of the present species. *T. stachei*, Kittl (1903, p. 45, pl. vii, fig. 14), has more prominent spines, confined entirely to the last whorl.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan. Dalmatia.

SPECIMENS :

C. 23172-3. Muć, Dalmatia. Nat. Hist. Museum, Vienna, 1922.

Tirolites angustus, Kittl.

1903, p. 47, pl. vii, fig. 12.

DIAGNOSIS. Like *T. robustus* and *T. quenstedti*, but with more evenly rounded whorl-section, smaller umbilicus, and 6-8 spines. Lateral lobe generally slightly toothed.

MEASUREMENTS :

Holotype (Kittl, p. 47)	.	42	.	·38	.	·33	.	·34
Paratype („ „)	.	49	.	—	.	—	.	·37

REMARKS. This is another species of doubtful value. Of the two examples in the Collection (*ex* Kittl Coll.), one is worn and may well belong to *T. quenstedti* ; the other, with wide ventral area, does not seem to differ in any essential from Kittl's figure of *T. robustus* var. *cornu* (1903, pl. vii, fig. 11).

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan. Dalmatia.

SPECIMENS :

C. 23154-5. Muć, Dalmatia. *Nat. Hist. Museum, Vienna, 1922.*

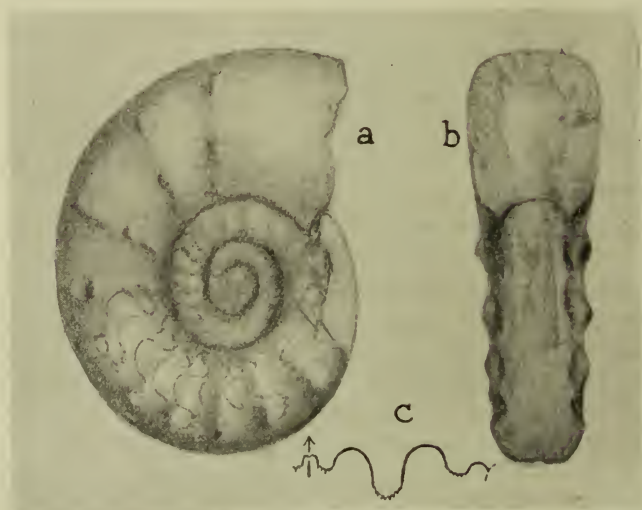


FIG. 127.—*Tirolitoides prior* (Kittl). Lower Trias. Dolnje Muć, Dalmatia. (After Kittl, 1903, pl. xi, fig. 13.)

Genus **TIROLITOIDES**, nom. nov.

(= *Paraceratites*, Kittl, 1903, p. 28, non Hyatt, 1900.)

GENOTYPE. *Ceratites* (*Paraceratites*) *prior*, Kittl, 1903, p. 29, pl. xi, fig. 13 (lectotype), figs. 4a, b.

DIAGNOSIS. Tirolitids with umbilical nodes as well as peripheral tubercles. Suture-line showing two toothed lateral lobes, and the external lobe more subdivided than in typical *Tirolites*.

DISTRIBUTION. Upper Eo-trias, Columbitan (Upper Werfen Beds). Dalmatia.

REMARKS. Kittl considered the present group to represent a Ceratitid stock, distinguished from the early *Xenodiscus* and *Xenaspis* by its bi-tuberculate ornamentation, and from its successors *Durgaites* and *Ceratites* s.s. by the absence of auxiliary lobes. It is probable, however, that *Tirolitoides* is merely a bi-tuberculate type of Tirolitid, combining the umbilical node

of *Dinarites* with the outer spine and advanced suture-line of such a form as *Tirolites toulai*, Kittl (1903, p. 64, pl. xi, figs. 11, 12), but leaving no progeny.

Diener (1915a, p. 214) identified Kittl's *Paraceratites* with "*Xenodiscus*", which is inadmissible. The true Permian *Xenodiscus* and *Xenaspis*, Waagen, were united by Kittl in his "*Proceratites*" (see p. 71), which, like his "*Paraceratites*", cannot be used.

? Genus **DIAPLOCOCERAS**, Hyatt.

1900, p. 556 (= *Liccaites*, Kittl, 1903, p. 12).

GENOTYPE. *Dinarites liccanus*, Hauer, 1865, p. 616, pl. iii, figs. 1-3.

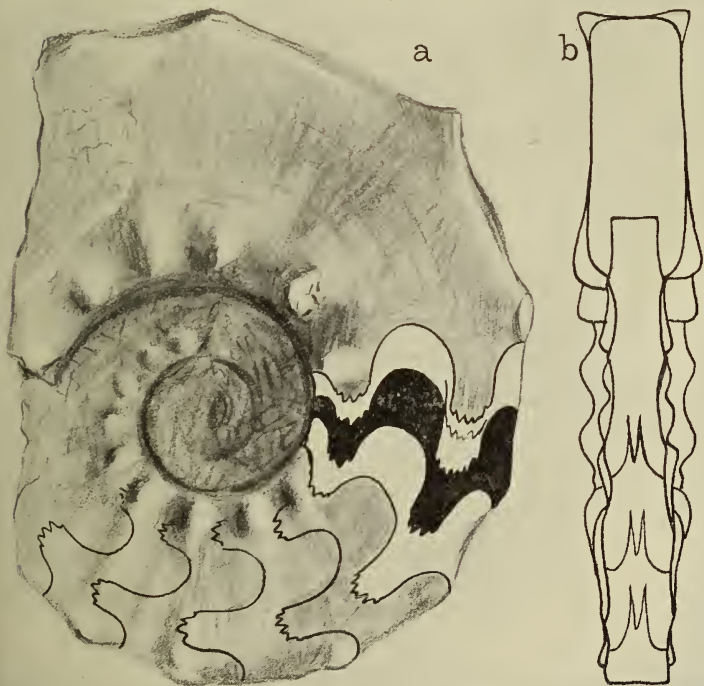


FIG. 128.—*Diaplococeras liccanum* (Hauer). Side- and diagrammatic peripheral views of an example from the Upper Eo-trias of Vrello, Croatia. (Adapted from Mojsisovics, 1882, pl. iv, figs. 1a, b, and reduced to about $\frac{4}{5}$ linear; venter corrected.)

DIAGNOSIS. Tirolitids? with toothed lobes and a tendency to develop umbilical tubercles and peripheral clavi.

DISTRIBUTION. Upper Eo-trias, Columbitan. Alps; Dalmatia.

REMARKS. As in the case of *Pseudodinarites* and *Hercegovites*, Hyatt's generic name has priority over Kittl's *Liccaites*, and must be adopted. With Kittl we may attach to this group also *Dinarites connectens* and *D. circumplicatus*, Mojsisovics; but *D. progressus*, Kittl, with toothed lobes but no tuberculation, is transitional to certain Dinaritids, and can only doubtfully be attached to *Diaplococeras*. The resemblance noted by Mojsisovics of the genotype of the present genus to the "Circumplicati" (including what is here separated as *Olenikites*) on the one hand, and to *Keyserlingites* (= group of *Ceratites middendorffi*, Keyserling) on the other, suggests that the Stephanitidæ and Tirolitidæ had a common origin.

The genus *Diaplococeras* is not represented in the Collection.

Genus SVILAJITES, Kittl.

1903, p. 65 (as sub-genus of *Tirolites*).

GENOTYPE. *Tirolites* (*Svilajites*) *cingulatus*, Kittl, 1903, p. 65, pl. viii, fig. 18.

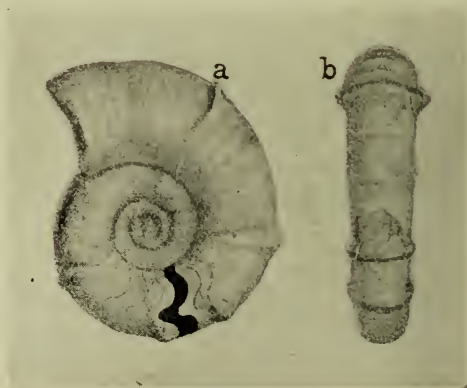


FIG. 129.—*Svilajites cingulatus* (Kittl). Lower Trias. Dolnje Muć, Dalmatia. (After Kittl, 1903, pl. viii, fig. 18.)

DIAGNOSIS. Tirolitids with transverse ribs across an arched periphery.

DISTRIBUTION. Upper Eo-trias, Columbitan (Upper Werfen Beds). Dalmatia.

REMARKS. Kittl considered this group to be derived from the spinose *Tirolites*, with which they are connected by transitions; and perhaps to be ancestral to *Cuccoceras* of the Anisian. The latter genus is, however, here attached to *Balatonites* and the Ceratitids in the wider sense.

Genus **BITTNERITES**, Kittl.

1903, p. 66 (as sub-genus of *Tirolites*).

GENOTYPE. *Tirolites* (*Bittnerites*) *bittneri*, Kittl, 1903, p. 67, pl. xi, fig. 10.

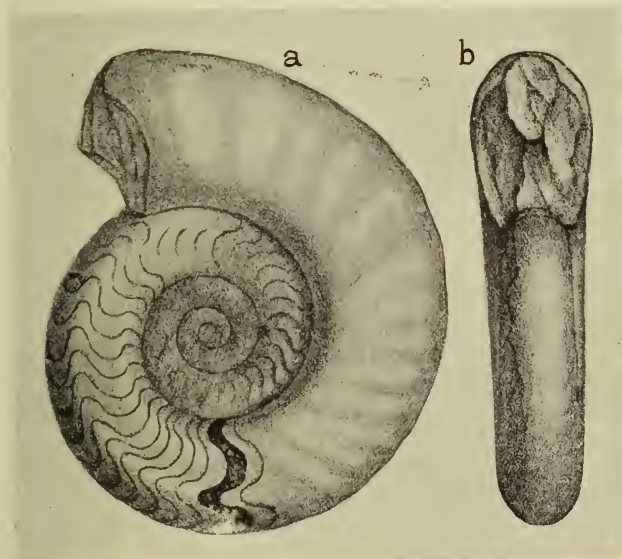


FIG. 130.—*Bittnerites malici* (Kittl). Lower Trias. Dolnje Muć, Dalmatia. (After Kittl, 1903, pl. iii, fig. 8, slightly reduced.)

DIAGNOSIS. Evolute Tirolitids with the spinose stage reduced or absent, and only blunt, indistinct ribs on outer whorls, projected and continuous across venter.

DISTRIBUTION. Upper Eo-trias, Columbitan (Upper Werfen Beds). Dalmatia.

REMARKS. Kittl drew attention to the similarity of the smooth forms of the present genus, such as *B. malici*, Kittl, here figured (fig. 130), to Waagen's "*Dinarites*" *evolutus* (1895, p. 32,

pl. x, fig. 3), dealt with above under *Xenoceltites*. The Spitsbergen forms, previously (Spath, 1921, p. 302) stated to be very close to Waagen's Upper Ceratite Limestone species, have a suture-line entirely different from that of *Bittnerites*, but it is interesting to note that this genus, like *Pseudodinarites*, is probably near to the persistent, smooth radical stock from which all these Upper Eo-Triassic families sprang. The appearance of tuberculation on the inner whorls of certain Tirolitids alone necessitated greater evolution, as compared with that on such forms as the more involute *Carniolites*, where the spines are confined to the body-chamber. But there is no evidence for a genetic series from *Dinarites*, through *Carniolites* and the "seminudi", to the "spinosi"; and zonal collecting may well prove *Tirolites*, with highly tuberculate inner whorls, to be the earliest to appear.

INCERTÆ SEDIS.

? Genus **DORIKRANITES**, Hyatt.

In Whiteaves, 1889, p. 145; in Zittel-Eastman, 1900, p. 556 (= *Doricranites*); Kittl, 1903, p. 11 (= *Bogdoites*).

GENOTYPE. *Ammonites bogdoanus*, v. Buch, 1831, pl. ii, fig. 1.

DIAGNOSIS. ? Tirolitidæ with evolute, discoidal shells, with ribs or tuberculation as in Tirolitids, but with acute venters. Suture-line simple, with lobes entire or slightly toothed at the siphonal or umbilical ends; dorsal lobe long and narrow, as in *Meekoceras* (compare fig. 86a, p. 253).

DISTRIBUTION. Upper Eo-trias, Columbitan?. Astrakhan, S. Russia.

REMARKS. This genus was included by Hyatt (1900, p. 556) in the family Badiotitidæ, but was omitted in J. P. Smith's revision of the chapter on Cephalopoda in the second English edition of Zittel's 'Textbook of Palæontology' (1913), also in the latest German editions. Arthaber (in Frech, 1905, p. 440) listed species of *Dorikranites* as "*Hungarites*", but added as synonyms *Doricranites* [sic] and *Bogdoites*. There is resemblance to *Balatonites* and *Hungarites*, somewhat similar offshoots of Ceratitids, also to the equally unrelated *Badiotites*; but whorl-shape as well as ornamentation and suture-line may be merely modified Tirolitid features; for Mojsisovics (1882, p. 87) already considered it probable that the group here discussed was derived from *Tirolites*. The resemblance to *Vishnuites* and *Subvishnuites*, *Inyoites* and *Metinyoites* is confined to a

similarly acute periphery, a transient character which appears in many unrelated stocks. *Japonites* and *Sibyllites*, which were considered to be analogous by Kittl (1903, p. 11), are again unrelated offshoots of yet different families (Gymnitidæ and Tropitidæ respectively).

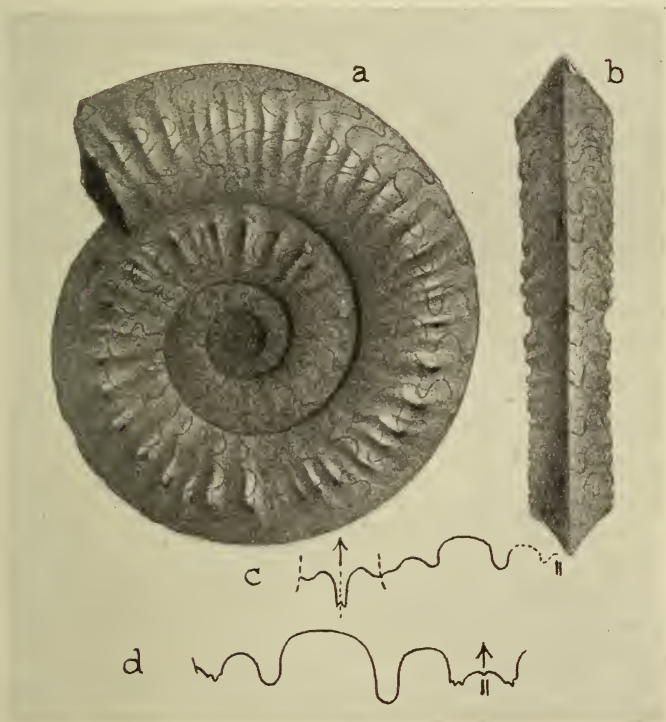


FIG. 131.—*Dorikranites bogdoanus* (v. Buch). Side- and peripheral views, internal and external suture-lines of an example from the Lower Trias. Bogdo Mountain, Astrakhan. (After Mojsisovics, 1882, pl. lxxx, figs. 2a, b, 3c, 4.)

***Dorikranites bogdoanus* (L. v. Buch).**

1831, pl. ii, fig. 1 ; Diener, 1915a, p. 129.

DIAGNOSIS. Substenogyral, subleptogyral, latumbilicate *Dorikranites*, with tuberculate costation on inner whorls, as in *Tirolites*, then fine lineation, a return to nodate ribbing, with,

finally, a secondary degeneration on the body-chamber. Venter acute; suture-line with two entire lateral lobes and (exceptionally) an auxiliary lobe at the umbilical suture (see fig. 131c, d).

MEASUREMENTS :

Mojsisovics, 1882, p. 88, No. I .	102	·30	·18	·49
„ „ „ „ II .	65	·28	·18	·51

REMARKS. The only fragment in the Collection agrees with Mojsisovics's examples, of which the smaller is here refigured (fig. 131, p. 383). The closely related *D. rossicus*, Mojsisovics, differs merely in being more involute and in having slightly different ornamentation; but it was considered by its author to be possibly the descendant of a different *Tirolites* stock. The third known species, *D. acutus*, is still more involute, and has distant, non-tuberculate folds.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan? (*Tirolites* Beds). Astrakhan.

SPECIMENS :

C. 1509. Mt. Bogdo, Govt. Astrakhan, Southern Russia.

R. Damon, 1886.

E. Family DINARITIDÆ, Mojsisovics emend.

1882, p. 5.

DIAGNOSIS. Discoidal, smooth, feebly or strongly ornamented ammonites with very simple, entire, or feebly ceratitic suture-lines and typically only one lateral lobe.

REMARKS. Forms like *Dinarites evolutior*, Kittl, indicate that the persisting, simple root-stock which produced such "*Lecanites*" and "*Ophiceras*" as were referred to under *Wyomingites* and *Submeekoceras*, probably also gave rise to Dinaritidæ, with simplified suture-lines, but specialized ornamentation. The genera *Dinarites*, Mojsisovics, *Pseudodinarites* and *Plococeras*, Hyatt, *Hololobus*, Kittl, *Carniolites*, Arthaber, are here referred to Dinaritidæ, but there are apparent transitions to the genera included above in the Tirolitidæ. *Olenikites*, already discussed, is now also included with *Keyserlingites* in the family Sibiritidæ. The resemblance to the inner whorls of *Xenoceltites* suggests that the appearance of supporting spines in the young (see Spath, 1926, p. 140) may have been the cause of the simplification of the suture-line.

Genus **DINARITES**, Mojsisovics.

1882, p. 5; Diener, 1915a, p. 120.

GENOTYPE. *Ceratites muchianus*, Hauer, 1865, p. 613, pl. ii, figs. 5, 6.

DIAGNOSIS. More-or-less involute, discoidal Dinaritidæ with rounded, or more rarely flattened, venter. Sides smooth, or with faint radial folds. Suture-lines with only two entire lobes and saddles.

DISTRIBUTION. Upper Eo-trias, Columbitan. Alps; Dalmatia; Bosnia.

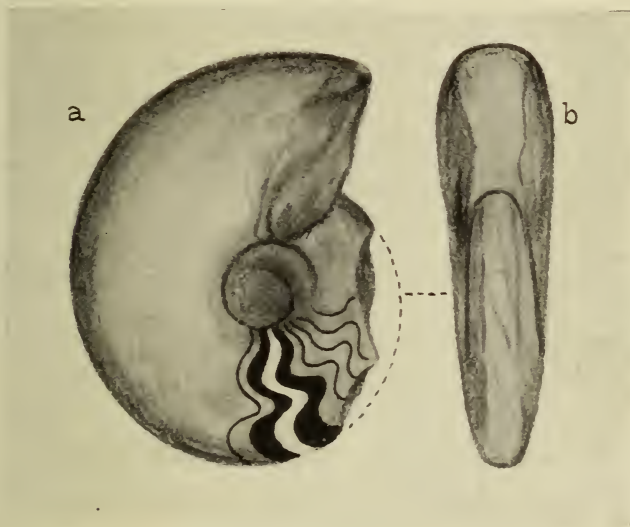


FIG. 132.—*Dinarites muchianus* (Hauer). Side- and peripheral views of an example from the Upper Eo-trias of Gornje Muć, Dalmatia. (Adapted from Kittl, 1903, pl. i, fig. 6.)

REMARKS. In the restricted sense, *Dinarites* excludes the strongly ribbed and the evolute forms, which are here referred to *Plococeras* and *Pseudodinarites* respectively. J. P. Smith, in Hyatt and Smith (1905, p. 161), again included these genera with *Diaplococeras* and the entirely distinct *Protophicerias*, Hyatt, in *Dinarites*; and he described as *Dinarites* a still less closely related *Cuccoceras* of the Anisian. His selection of *Dinarites dalmatinus* (Hauer) as the genotype of *Dinarites* cannot be accepted, because this species had already been designated as the genotype of *Plococeras*, Hyatt (1900, p. 556),

and I follow Diener in taking as type *D. muchianus* (Hauer), the first species described by Mojsisovics.

***Dinarites muchianus* (Hauer).**

Fig. 132, p. 385.

1865, p. 613, pl. ii, figs. 5, 6 ; Diener, 1915a, p. 121.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Dinarites*. Whorl-section compressed, with flattened, smooth or feebly striated sides and arched venter. Suture-line with one pointed entire lateral, and indistinct umbilical, lobe.

MEASUREMENTS :

Kittl, 1903, p. 16, No. I	. 50	. 44	. 29	. 23
" " " " V	. 50.5	. 50	. 23	. 22

REMARKS. This species is distinguished from *D. lævis* by less compression and a larger umbilicus. One of the examples in the Klipstein Collection was labelled "*D. nudus*, Mojs.", a species characterized by greater whorl-thickness and less simple suture-line ; but the fragment is badly preserved and altogether doubtful, and may have been separated from the present species only because it is compressed obliquely, not laterally, as is commonly the case. Its suture-line has a rounded lateral lobe.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan. Alps ; Dalmatia ; Bosnia.

SPECIMENS :

C. 27877-8. St. Cassian, Tyrol. *Klipstein Coll.*, 1851.

C. 23148-50. Dolnje Muć, Dalmatia.

Nat. Hist. Museum, Vienna, 1922.

***Dinarites lævis*, Tommasi.**

1902, p. 347, pl. xiii, figs. 4, 5 ; Kittl, 1903, p. 13, pl. i, fig. 1.

DIAGNOSIS. Like last, but with smaller umbilicus.

MEASUREMENTS :

Tommasi, 1903, p. 348	. 51	. 51	. 24	. 16
Kittl, 1903, p. 14, No. I	. 47	. 53	. 20 ?	. 13
C. 23145	. 38	. 50	. ?	. 17

REMARKS. The two crushed individuals here listed seem to be identical with Tommasi's type, that is, they are transitional between *D. muchianus* and the more involute species figured by Kittl (pl. i, fig. 1), and show a comparatively open umbilicus.

Kittl, however, stated the width of the umbilicus to vary from one-sixth to one-eighth of the diameter, as compared with one-quarter to one-fifth in *D. muchianus*. It is probable that, as Kittl stated, the present form represents merely a variety of Hauer's species, and that Kittl's first example is more extreme than either Tommasi's type or the two examples here listed.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan. Eastern Alps; Dalmatia; Bosnia.

SPECIMENS :

C. 23144-5. Dolnje Muć, Dalmatia.

Nat. Hist. Museum, Vienna, 1922.



FIG. 133.—*Pseudodinarites mohamedanus* (Mojsisovics). Fragmentary, large example from the Upper Eo-trias of Gornje Muć, Dalmatia. (After Kittl, 1903, pl. iii, fig. 5.)

Genus **PSEUDODINARITES**, Hyatt.

1900, p. 559 (= *Hercegovites*, Kittl, 1903, p. 13).

GENOTYPE. *Dinarites mohamedanus*, Mojsisovics, 1882, p. 7, pl. xl, fig. 12.

DIAGNOSIS. Evolute, smooth Dinaritids, with lobes toothed, not entire.

DISTRIBUTION. Upper Eo-trias, Columbitan. Dalmatia; Hercegovina.

REMARKS. Hyatt separated Mojsisovics's species as an independent genus, but this arrangement was not adopted by Diener (1915*a*, pp. 122, 236), who accepted Kittl's later "*Hercegovites*" as a sub-genus of *Dinarites*. Hyatt's genus, however, although it was defined only by the mention of the genotype *Dinarites mohamedanus*, must stand, even if, owing to scarcity of material, it is at present difficult to form a satisfactory opinion of this genus. The smaller examples figured by Kittl (1903, pl. iii, figs. 6, 7) do not differ greatly from certain *Plococeras*, except in the serrated lobes. Mojsisovics stated that small examples of *Pseudodinarites mohamedanus* still showed entire lobes, but, as Kittl pointed out, no observations are yet available to prove that this change actually occurred in the same individual. It is also doubtful whether *Pseudodinarites* includes "*Hercegovites*" *diocletiani*, Kittl (1903, p. 23, pl. iii, fig. 4), with ribbing resembling that of *Plococeras multicostatum* (Kittl), but the suture-line of *Pseudodinarites* and of "*Liccaites*" *progressus*, Kittl.

Genus **PLOCOCERAS** Hyatt.

1900, p. 556.

GENOTYPE. *Ceratites dalmatinus*, Hauer, 1865, p. 615, pl. ii, figs. 3, 4.

DIAGNOSIS. Dinaritids with coarse folds and entire suture-lines.

DISTRIBUTION. Upper Eo-trias, Columbitan. Dalmatia; Bosnia.

REMARKS. Kittl (1903, p. 18) and Diener (1915*a*, p. 225) left *Plococeras dalmatinum* in *Dinarites*, and there are, indeed, numerous transitions between the two groups. Since all the sub-divisions within the families Dinaritidæ and Tirolitidæ are at present based merely on slight morphological differences, and since only future careful zonal collecting will show whether these subdivisions are tenable and useful, *Plococeras* may be provisionally accepted.

Plococeras dalmatinum (Hauer).

1865, p. 615, pl. ii, figs. 3, 4 (*Ceratites*); Kittl, 1903, p. 18, pl. ii, figs. 1-7; Diener, 1915*a*, p. 120; 1925, p. 80, pl. xii, figs. 2*a*, *b* (*Dinarites*).

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Plococeras*. Whorl-section compressed, with flattened sides

and arched or subtabulate venter. About nine coarse pleats, tending to disappear on the larger body-chambers. Suture-line as in *Dinarites* s.s.

MEASUREMENTS :

Kittl, 1903, p. 20, No. I (fig. 4)	.	50	·44	·34	·30
„ „ „ „ III (fig. 5).		64	·42	·27	·25

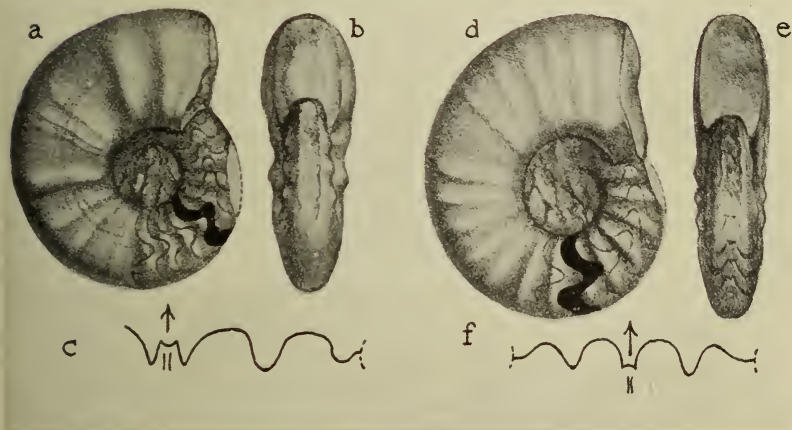


FIG. 134.—a, b, d-f, *Plococeras dalmatinum* (Hauer), var. *externepplanata*, Kittl. Side- and peripheral views and suture-line of two examples from the Upper Eo-trias of Muć, Dalmatia. c, Suture-line of *P. dalmatinum* (Hauer) from the same formation and locality. (After Kittl, 1903, pl. iii, figs. 2, 3, and pl. ii, fig. 4 [*partim*].)

REMARKS. This well-known species is represented in the Collection by only one typical example (C. 23146), and a second specimen (C. 23147) that is probably referable to Kittl's var. *externepplanata* (pl. iii, fig. 1), characterized by its wide ventral area.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan. Dalmatia.

SPECIMENS :

C. 23146-7. Muć, Dalmatia.

Nat. Hist. Museum, Vienna, 1922.

Plococeras tirolitoides (Kittl).

1903, p. 21, pl. vii, figs. 1-3.

DIAGNOSIS. Like the last, and especially its var. *externeplanata*, but with more marginal lateral lobes and sharper ribs, mostly also with slightly larger umbilicus and flatter ventral area.

MEASUREMENTS :

Kittl, 1903, holotype . . .	39	. 41	. 31	. 31
„ var., pl. vii, fig. 2	52	. 42	. 32	. 33
„ var., pl. vii, fig. 3	45	. 40	. 32	. 26

REMARKS. This species is transitional to *Tirolites*, but although the ribs may become thickened at the edge of the wide ventral area, no actual tubercles are produced.

Plococeras multicostatum, Kittl sp. (1903, p. 21, pl. iii, fig. 3), is more evolute and has the lateral saddle at the middle of the side; its ribs are also more numerous and not so distinctly thickened. The typical *P. dalmatinum* also is less strongly ribbed and has a narrow, arched periphery.

HORIZON AND LOCALITIES. Upper Eo-trias, Columbitan. Dalmatia.

SPECIMENS :

C. 23151. Muć, Dalmatia. *Nat. Hist. Museum, Vienna*, 1922.

Genus **HOLOLOBUS**, Kittl.

1903, p. 32 (as sub-genus of *Tirolites*).

GENOTYPE. *Tirolites (Hololobus) monoptychus*, Kittl, 1903, p. 33, pl. iv, fig. 9.

DIAGNOSIS. Dinaritidæ intermediate between *Dinarites* and *Carniolites*, with entire, undivided external lobe.

DISTRIBUTION. Upper Eo-trias, Columbitan (Upper Werfen Beds). Dalmatia.

REMARKS. The type species is based on a single, poorly preserved example. Its *Tornoceras*-like suture-line is characteristic, but it may be merely an individual modification of a form like *Tirolites carniolicus* (see below under *Carniolites*) or of some "seminude" Tirolitid. It is interesting to note that Kittl could find no trace of an external siphuncle; but he considered it improbable that it was internal (dorsal) as in Clymenids. If it were, *Hololobus* could be used as evidence in favour of Sobolew's views (see p. 6).

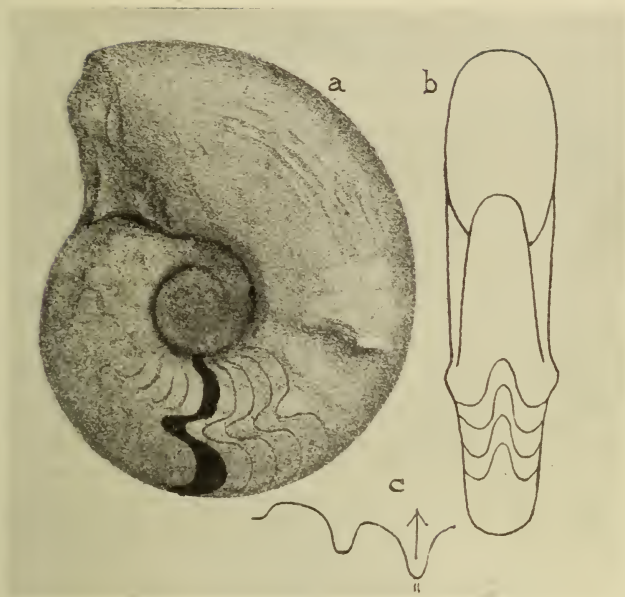


FIG. 135.—*Hololobus monoptychus* (Kittl). Lower Trias. Muć, Dalmatia. (After Kittl, 1903, pl. iv, fig. 9.)



FIG. 136.—*Carniolites carniolicus* (Mojsisovics). Lower Trias. Muć, Dalmatia. (After Kittl, 1903, pl. v, fig. 1.)

Genus **CARNIOLITES**, Arthaber.

1911, pp. 241, 250.

GENOTYPE. *Tirolites carniolicus*, Mojsisovics, 1882, p. 65, pl. i, figs. 2-3.

DIAGNOSIS. Dinaritids with only a few spines on the body-chamber, but the camerated portion as in *Dinarites*.

DISTRIBUTION. Upper Eo-trias, Columbitan (Upper Werfen Beds). Dalmatia.

REMARKS. In view of the separation of *Tirolites* and *Dinarites* into two separate families, and in spite of the (apparently) intermediate nature of *Carniolites* (and probably also *Hololobus*, if its simple external lobe be found to represent a constant feature), it is impossible to retain them as sub-genera of *Tirolites*. They are believed to be closer to *Dinarites*, and it is probable that spines or folds appeared, not in the sequential (recapitulational) manner assumed by Kittl, but indiscriminately, on the inner whorls of some Dinaritids (*Plococeras*), and on the body-chambers of others (*Hololobus*), perhaps in response to some environmental stimulus.

F. Family **ACROCHORDICERATIDÆ**, Arthaber, emend.

1911, p. 179.

DIAGNOSIS. More-or-less involute, often inflated ammonites with strong costation, continuous across, and generally most prominent on, the arched periphery; with or without umbilical tubercles. Suture-line ceratitic to ammonitic, with more-or-less advanced subdivision of saddles.

REMARKS. Arthaber included in this family the four genera *Acrochordiceras*, *Stephanites*, *Anasibirites* [= "*Pseudosibirites*"] and *Sibirites*. They are here taken to be representatives of the three families *Acrochordiceratidæ*, *Stephanitidæ* and *Sibiritidæ*, and it is not even considered advisable to regard these as merely sub-families. It is altogether doubtful whether *Acrochordiceras*, with tuberculation developed at a comparatively late stage, is a direct descendant of either *Stephanites* or the *Sibiritids*, the latter being at least equally closely related to the *Prionitids*. The adult Anisian *Acrochordiceras* with flattened periphery and outer spines shows a striking similarity to the *Ceratitids*,

as well as to such forms as *Durgaites*; but the earliest known forms, like *A. inyoense* from the *Parapopanoceras* Beds of California, are evolute like the Timor *A. anodosum*, Welter (1915, p. 111, pl. lxxxix, figs. 3a-c), or the Himalayan *A. joharensense*, Diener (1895b, p. 36, pl. vii, figs. 4a-c). Although derivation from the stock which also produced the Sibiritids, e.g. *Anasibirites*? *spitiensis* (v. Krafft) and *Durgaites* is considered probable, there is the extraordinary resemblance of at least some forms to Danubitids ("*Floriantes*") and Ceratitids in suture-line and ornamentation. This makes it possible that the tuberculation was acquired independently at different times by different stocks, and *Acrochordiceras* would thus be polyphyletic. The resemblance to the Salt Range forms of Stephanitids described by Waagen as "*Acrochordiceras*" is not very close, and apparently provides another case of convergence.

Genus **ACROCHORDICERAS**, Hyatt.

1877, p. 124; Diener, 1915a, p. 27; Kutassy, 1933, p. 393.

GENOTYPE. *A. hyatti*, Meek, 1877, p. 124, pl. xi, figs. 5, 5a.

DIAGNOSIS. As family diagnosis above. In the restricted sense (sub-genus *Acrochordiceras* s.s.) characterized by umbilical tubercles in young and ceratitic body-chambers with flattened ventral area. Suture-line simpler than in *Silesiacrochordiceras*.

DISTRIBUTION. Mesotrias, Beyrichitan and Paraceratitan. Alps; Bosnia; Albania; Greece; Roumania; Asia Minor; Himalayas; Timor; Ussuri Bay (Sea of Japan); Nevada; California.

REMARKS. Of the numerous species listed by Diener, Noetling's *A. damesi* was separated in 1916 as *Silesiacrochordiceras* (see below). Several additional forms have since been described, like *A. anodosum*, Welter (1915, p. 111, pl. lxxxix, figs. 3a-c) and *A. alternans* and *A. foltzense*, Smith. The former has some resemblance to *A. inyoense*, Smith (1914, p. 40, pl. xxxiv, figs. 11-13), and since they differ from all the other forms in being evolute and non-tuberculate, they may well be separated as a sub-genus (see *Paracrochordiceras* below). The two Nevada specimens, however, look too much like malformations of *Gymnotoceras* (with costation more-or-less continuous across the periphery) to be included with certainty in *Acrochordiceras*.

The remaining species belong to two groups; in the first, typified by *A. carolinæ*, there are tuberculate inner whorls, like the incompletely known genotype, *A. hyatti*, and the outer

whorls acquire an entirely different, *Durgaites*-like type of ornamentation. It is now proposed to restrict *Acrochordiceras* to this group, connected, however, with the first by certain forms from the Gulf of Ismid and, perhaps, by *A. balarama*, Diener (1895*b*, p. 35, pl. vii, figs. 3*a-c*). The Himalayan *A. joharensse*, Diener (*ib.*, figs. 4*a-c*) is a still more doubtful member of this group.

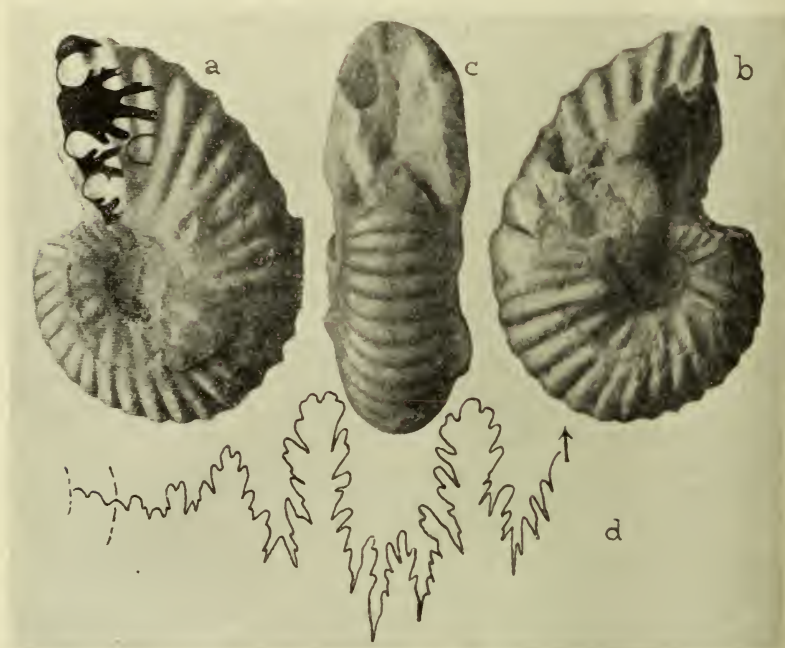


FIG. 137.—*a-c*, *Acrochordiceras hyatti*, Meek. Two side- and peripheral views of a specimen from the Middle Trias of Nevada. (After Hyatt and Smith, 1905, pl. xxiii, figs. 8–10.) *d*, *Acrochordiceras* (*Epacrochordiceras*) *enode*, Hauer. Suture-line. Middle Trias, Bosnia. (After Hauer, 1892, pl. vii, fig. 1*c*.)

The second division includes the *pustericus*-*enode* assemblage, in which costate, non-tuberculate ornament tends to be lost on the body-chamber, and the suture-line shows frilling on the whole of the saddles. There is great resemblance to the Beyrichitids, well shown in the form referred below to *A. portisi*, Martelli, which may be taken to be typical of a sub-genus *Epacrochordiceras*.

Sub-genus **ACROCHORDICERAS**, s.s.

DIAGNOSIS. See generic diagnosis above.

Acrochordiceras carolinæ, Mojsisovics.

1882, p. 141, pl. xxviii, fig. 14 (lectotype); pl. xxxvi, fig. 3; Diener, 1915*a*, p. 27; Gugenberger, 1927, p. 144; Kutassy, 1933, p. 394.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Acrochordiceras*. Whorl-section compressed elliptical, with broadly arched venter and greatest thickness at the tubercles close to the umbilical edge. About seven umbilical bullæ to a whorl, with bifurcating costæ, and long or short intermediaries, first three, and later, four. All ribs tending to thicken as they pass with a slight forward sinus across the periphery. In the adult the tubercles disappear and the venter becomes smooth. Suture-line ceratitic, as in *A. hyatti* (see fig. 137*a*).

MEASUREMENTS :

Lectotype	30	·50	·40	·27
Paratype (Mojsisovics, pl. xxxvi, fig. 3)	90	·48	·43	·23
? C. 28637 (Muth, Spiti)	46	·48	·43	·26

REMARKS. This species is connected by transitions with the more inflated *A. haueri* (e.g. C. 21251) and the more compressed *A. undatum*, Arthaber (e.g. C. 20489). That author at first included in his species two distinct forms, of which one (1896, pl. xxvii, fig. 2) was subsequently referred by Diener (1907, pp. 99–101, 1915*a*, p. 29) to *A. carolinæ*.

A large example (C. 21271) of over 200 mm. diameter has one half of the outer whorl belonging to the body-chamber and the last umbilical tubercle at a diameter of 130 mm. Here already there is weakening of the ventral ribbing, which on the final half-whorl breaks up into irregular striæ, whilst at the same time the whorl-sides become flat and the section almost quadrate. The ribs become sharp, move away more and more from the abrupt umbilical edge, but become increasingly prominent at the ventro-lateral angles, where they are strongly projected forwards. The ventral aspect then is not unlike that of *Haydenites hatscheki*, Diener, figured by J. Perrin Smith (1914, p. 114, pl. xxxiii, fig. 2), but the ribs are sharper, more curved, and prorsi-radiate laterally.

Another example (C. 21255) shows the change to a ceratitic

ornament at a much earlier stage (about 100 mm.), when others are still typically tuberculate, although owing to the imperfection it is impossible to state whether the considerable individual differences shown by most of the specimens are not perhaps due to their belonging to distinct species. Two large fragments in the Collection (C. 21230, 31108) are altogether doubtful, and the single Himalayan example available is included here only provisionally.

HORIZON AND LOCALITIES. Lower Anisian, Meso-trias (*trindosus* zone). Alps; Balkans; Himalayas.

SPECIMENS :

C. 20445, 20460-67, 21247-50, 21252, 21255, 21257, 21271, 21230 (?). Stavljan, Volujak Mts., Bosnia.

V. Hawelka Coll., 1906-08.

C. 20489. Suha on the Sutjeska, Bosnia. Same Coll.

C. 30575, 30578, 30588. Mali Durmitor Mts., Montenegro.

V. Hawelka Coll., 1926.

C. 28637. Muth, Spiti.

Coll. Hayden. Presented Geol. Surv. India, 1927.

C. 15035. Dil-Iskelessi, Gulf of Ismid, Asia Minor.

Dr. W. Endriss Coll., 1911.

Acrochordiceras haueri, Arthaber.

1911, p. 272 (= *A. damesi*, Hauer, non Noetling, 1887, p. 22, pl. v, fig. 2); 1914, p. 182, pl. xiv, figs. 5, 6.

DIAGNOSIS. Like *A. carolinæ*, but with whorl-thickness about equal to whorl-height, and with coarser costation.

MEASUREMENTS :

Holotype (Hauer, p. 22) . . . 110 .50 .51 .20

REMARKS. Hauer interpreted his "*A. damesi*", which is certainly not identical with the Silesian type, in a very comprehensive manner. He was undoubtedly right in stating that every individual showed differences of detail, but it may be convenient to accept Arthaber's name for those numerous forms, intermediate between *A. carolinæ* and *A. fischeri*, that agree with Hauer's figure in the comparatively robust ornamentation and inflated whorl-shape. *A. carolinæ* is more compressed and more closely ribbed; *A. fischeri* represents an extreme type, with the whorl-thickness (including the spines), considerably greater than the height, and the ribs particularly thick and distant in the adult. The examples in the Collection

are not well preserved, but they differ from *A. fischeri* in being more finely ribbed or more compressed. The example from the Gulf of Ismid, provisionally listed here, probably belongs to a new species, and shows peculiar interruption of the ribs (not opposite) on the venter of the still septate outer whorl.

A. ippeni, Arthaber (1911, p. 271, pl. xxiv, fig. 11), which has been claimed to be the only post-Anisian *Acrochordiceras* known, is distinguished by its more numerous umbilical tubercles.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trinodosus* zone. Alps; Balkans.

SPECIMENS :

C. 21251. Stavljan, Volujak Mts., Bosnia.

V. Hawelka Coll., 1906-08.

C. 30580. Mali Durmitor Mts., Montenegro. *Same Coll.*, 1926.

C. 14017. Dil-Iskelessi, Gulf of Ismid, Asia Minor.

Dr. W. Endriss Coll., 1911.

***Acrochordiceras fischeri*, Mojsisovics.**

1882, p. 142, pl. xxxiii, figs. 8a, b; Diener, 1915a, p. 28.

DIAGNOSIS. Like *A. haueri*, but with whorl-thickness (including the very prominent umbilical tubercles) greater than the whorl-height, and with coarse peripheral ribbing.

MEASUREMENTS :

Holotype (Mojsisovics, p. 143)	. 70	·44	·60	·23
C. 20374	. 94	·46	·58	·29

REMARKS. There are numerous transitions between Mojsisovics's *A. carolinæ* and his *A. fischeri*; and to include them all in one species, "*A. haueri*", may be convenient, but does not help towards a satisfactory classification. The example (C. 20374), of which the measurements are given, shows very good agreement with Mojsisovics's figure at the same diameter, but it has a broader periphery, so that the transverse section is more depressed than in Mojsisovics's drawing. In this example the tuberculation decreases at a larger diameter, as it does apparently in the original, whilst the umbilicus widens at the same time.

There is another type, however, probably a new species, in which the coarse umbilical tuberculation continues to increase until, at a diameter of about 135 mm., the spines are as much as 10 mm. high or 30 mm. above the umbilical suture. In

this form the umbilicus remains small (20% of the diameter), and the whorl-thickness increases from 60% at 56 mm. diameter to 68% at 100 mm., and to 70% at 135 mm. The example is still septate at the end, but the peripheral ribbing is almost lost on the outer half-whorl, giving this form an aspect altogether different from that of the smaller typical example of *A. fischeri*.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trindodus* zone. Alps; Balkans.

SPECIMENS :

C. 20374, 21229 (?). Stavljan, Volujak Mts., Bosnia.

V. Hawelka Coll., 1906-08.

Acrochordiceras halili, Toula.

1896, p. 168, pl. xix, figs. 10a-d; Arthaber, 1914, p. 181, pl. xiv, fig. [3 ?-] 4; Diener, 1915a, p. 28.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Acrochordiceras*. Inner whorls loosely coiled, with rounded whorl-section and numerous single costæ, as in *Paracrochordiceras*, but tubercles appearing on some. In later stages more like *A. carolinæ*. Suture-line with more regularly toothed lobes than in *A. hyatti*.

MEASUREMENTS :

Holotype	.	.	.	59	.	48	.	35 ?	.	27
C. 15034	.	.	.	48	.	45	.	45	.	29

REMARKS. Four of the five examples in the Collection are poorly preserved and somewhat doubtful, but an incomplete large specimen (when perfect, probably about 150 mm. in diameter) has enough of the septate portion preserved to justify its definite identification with Toula's species. It is interesting to note that on the body-chamber, as in *A. carolinæ*, the ventral area becomes smooth and the ribs short (with one bifurcating at a lateral bulla) so as to leave an almost smooth inner zone near the abrupt umbilical edge. This is not unlike the type of ornamentation found in the much smaller and thinner *Ceratites* aff. *elegans*, Mojsisovics, figured by Toula (1896, pl. xx, figs. 1a, b), but the ribs in the present species are not so prorsiradiate.

The immature example (C. 15034), of which the measurements are given, has a more circular whorl-section than the type, and in ribbing somewhat resembles *A. (Paracrochordiceras) inyoense*, Smith (1914, p. 40, pl. xxxiv, figs. 11-13). The ventral area, however, is considerably more depressed in the

American form, and there is no trace of tuberculation. The Ismid form referred by Arthaber (1914, p. 180, pl. xiii, figs. 8a-c) to Diener's *Acrochordiceras balarama* is far more finely costate.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Asia Minor.

SPECIMENS :

C. 12401. Gulf of Ismid, Sea of Marmora. *Purchased* 1909.

C. 15033-4, 15036-7. Dil-Iskelessi, Gulf of Ismid.

Dr. W. Endriss Coll., 1911.

***Acrochordiceras undatum*, Arthaber.**

1896, pp. 79, 226, 235, pl. vii, figs. 7a, b (lectotype), 8 (*non* pl. xxvii, figs 2a-d) ; Gugenberger, 1927, p. 144.

DIAGNOSIS. Like *A. carolinæ*, but less tuberculate and more compressed (height to thickness = 8:5). Transitional to *Epacrochordiceras*.

MEASUREMENTS :

Lectotype (Arthaber's,

pl. vii, fig. 7) . . . 90 ? . 47 ? . 28 ? . 21 ?

C. 21245 . . . 84 . 50 . 39 . 23

C. 21266 . . . 145 . 50 . 35 . 20

REMARKS. There are several fragments in the Collection that, in ribbing, resemble *A. (Epacrochordiceras) enode* and *A. (E.) portisi*, but, like the more coarsely ornamented *A. carolinæ*, have tuberculate inner whorls ; or, like Arthaber's large fragment (pl. vii, fig. 7, *i. e.* the lectotype), still show indications of the umbilical bullæ on the outer whorls. It seems convenient to adopt Arthaber's name for this assemblage, even if some examples are doubtful. A number of fragments here listed with the far commoner *A. (E.) enode* are clearly transitional, the union of two ribs at the umbilical border producing a slight tubercle ; but specimens like that quoted above (C. 21245), with a greater whorl-thickness, are passage-forms to the more inflated varieties of *A. (E.) enode*.

The large and fine specimen (C. 21266), of which the measurements were cited above, seemed to be a typical *A. (E.) enode* with 45 ribs, until the umbilicus was cleared of matrix and revealed faint tuberculation. Another nearly perfect example (C. 20310), of dimensions 94- 49- 35- 20, shows increasingly coarse ribbing on the body-chamber and may

perhaps be a distinct variety, but its inner whorls, as in *A. (E.) portisi*, are far more compressed than Arthaber's fig. 8.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trinosus* zone. Alps; Balkans.

SPECIMENS :

C. 20375, 21244-6, 21256, 21266, 20310 (?). Stavljan, Volujak, Mts. Bosnia. V. Hawelka Coll., 1906-08.

Sub-genus **PARACROCHORDICERAS**, nov.

SUB-GENOTYPE. *Acrochordiceras anodosum*, Welter, 1915, p. 111, pl. lxxxix, figs. 3a-c.

DIAGNOSIS. Evolute *Acrochordiceras* with continuous costation across the periphery and resemblance to *Danubites* (" *Florinates* "), but no tuberculation as in *Acrochordiceras* s.s. and in *Silesiacrochordiceras*. Distinguished from *Epacrochordiceras* by rounded whorls and open umbilicus.

REMARKS. The unique holotype of *A. (P.) anodosum* is still septate at 43 mm. diameter, and the only example in the Collection is even smaller, so that the sub-genus is as yet incompletely known. *A. (P.) inyoense*, J. P. Smith (1914, p. 40, pl. xxxiv, figs. 11-13), with a subdivided external lobe, is also small (about 25 mm. diameter), but may be closer to the typical *Acrochordiceras* if the sudden increase in thickness shown in Smith's fig. 12 is continued at later stages. At least some of the examples referred to *A. halili* (see p. 398) connect *Paracrochordiceras* with the restricted *Acrochordiceras* s.s.

Acrochordiceras (Paracrochordiceras) anodosum, Welter.

Fig. 138.

1922, p. 111, pl. lxxxix, figs. 3a-c; Kutassy, 1933, p. 393.

DIAGNOSIS. Substeno-, subpachygyral, sublatumbilicate *Paracrochordiceras*, with high and rounded umbilical slope and rounded, depressed whorls. Costation reclined and blunt, single or irregularly bifurcating, tending to become increasingly robust on broad venter. Suture-line ceratitic, with two simple lateral lobes and undivided external lobe.

MEASUREMENTS :

Holotype	43	. 30	. 40	. 40
B.M., C.34115	29	. 33	. 41	. 42

REMARKS. The small example in the Collection might be compared to the inner whorls of "*Florianites*" *alternecostatus*, Welter (1915, p. 108, pl. lxxxvii, figs. 2-4), but although at an early stage the ribbing in this species may be continuous across the venter, the typical *Danubites* (= "*Florianites*") soon lose the peripheral ribbing. In *A. (P.) anodosum*, on the other hand, the strength of the costation on the venter shows a decided increase. The inner whorls of the other forms of *Acrochordiceras*, here described, are much more involute.

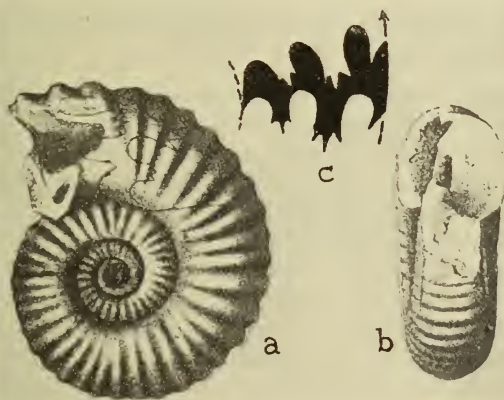


FIG. 138.—*Acrochordiceras* (*Paracrochordiceras*) *anodosum*, Welter.
Anisian. Nifoekoko, Timor. (After Welter, 1915, pl. lxxxix, figs. 3a-c.)

HORIZON AND LOCALITIES. Meso-trias, Anisian, Paraceratitan. Timor.

SPECIMENS :

C. 34115. Nifoekoko, Timor.

M. E. Walsh Coll., 1930.

Sub-genus **EPACROCHORDICERAS**, nov.

SUB-GENOTYPE. *Acrochordiceras portisi*, Martelli, 1906, as represented by the specimen (B.M., C. 21253), figured in Plate XVIII, figs. 2a, b.

DIAGNOSIS. *Acrochordiceras* with non-tuberculate ribbing, which is lost or weakened at some stage, generally on the body-chamber.

Acrochordiceras (Epacrochordiceras) pustericum,
Mojsisovics.

1882, p. 143, pl. vi, figs. 4a, b; Arthaber, 1914, p. 183, pl. xiv, figs. 7a-c; Diener, 1915a, p. 29; Gugenberger?, 1927, p. 144.

DIAGNOSIS. Platygyral, subleptogyral, angustumbilicate to subangustumbilicate *Epacrochordiceras*, with compressed whorl-shape with sub-parallel sides, distinct umbilical edge and arched venter. With close, slightly sigmoidal ribs, continuous across periphery with slight thickening and forward sinus. Suture-line similar to that of *A. halili* (see fig. 139d, p. 405).

MEASUREMENTS :

Holotype (Mojsisovics, pl. vi,

fig. 4)	.	.	.	.	87	.	.52	.	.30	.	.17
C. 13716	.	.	.	.	60	.	.50	.	.34	.	.20

REMARKS. Mojsisovics rightly thought it more probable that the species here described was the representative of an independent lineage than that it was the ancestor of the tuberculate *A. carolinæ*. The three examples in the Collection cannot, perhaps, be definitely identified with the holotype, of which the inner whorls and suture-line are unknown, but they are still more distinct from the later forms described below, and it is interesting to note that they had originally been referred to the contemporary *A. halili*, Toulou. The suture-line is similar, but in the absence of all tuberculation, and in view of their close and delicate sigmoidal ribbing and smaller umbilicus, the Ismid examples can be compared only to *A. (E.) pustericum*. After writing this I found that Arthaber had, indeed, described a comparable Ismid form as *A. pustericum*. The largest specimen (C. 14012), of about the size of Mojsisovics's holotype, is a body-chamber fragment with the ribs still continuous across the periphery where that is preserved. The second example (C. 13716, the suture-line of which is here figured, fig. 139d, p. 405) seems to have a smooth ventral area towards the end, but is corroded, whilst the smallest specimen (C. 13717), at about 35 mm. diameter, shows distinctly projected costæ running across the periphery. This is more tabulate than in the forms described below, and the sides are more sub-parallel, but the fine and close sub-falcoid ribbing is characteristic, with the thickening towards the venter far less pronounced than in the later forms. This feature is clearly shown in Arthaber's figures.

The convergence towards the Beyrichitids, *e.g.* "*Koninckites*" *libyssinus*, Toulà (1896*d*, pl. xxi, fig. 11), is interesting; but in the form described below as *A. (E.) portisi*, with more complex suture-line, there is an equally close resemblance to members of the same family, and even to the Ptychitids.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *binodosus* zone. Alps; Balkans; Asia Minor.

SPECIMENS:

C. 13716-7. Dil-Iskelessi, Gulf of Ismid, Anatolia.

Purchased, 1910.

C. 14012. Same locality.

Dr. W. Endriss Coll., 1911.

Acrochordiceras (Epacrochordiceras) enode, Hauer.

1892, p. 272, pl. vii, figs. 1*a-c*; Diener, 1915*a*, p. 28; Kraus, 1916, p. 320.

DIAGNOSIS. Like *Epacrochordiceras pustericum*, but more evolute, and with more complicated suture-line (see fig. 137*d*, p. 394).

MEASUREMENTS:

Hauer (1892, p. 273), I	.	180	.	·54	.	·31	.	·12
" " " II	.	117	.	·52	.	·32	.	·14
C. 21270	.	200	.	·50	.	·35	.	·14

REMARKS. It has already been mentioned that this species is connected by numerous transitions with *A. undatum*, and with only fragments of body-chambers, specific separation is often impossible. The large example above quoted (C. 21270) has a smooth venter at the end (with only striæ of growth), but specimens up to 150 mm. in diameter are typically ribbed throughout, with about 45 costæ to the whorl. *A. portisi*, Martelli, has been separated from the present species chiefly on account of differences in proportions and of details of the suture-line. Among a hundred specimens of *Acrochordiceras* from Bosnia and Montenegro in the Hawelka Collection there were about twenty-five tuberculate forms to seventy-five of the *enode* type, and probably no two examples of the latter group were identical. For example, it was found that some specimens agreeing with Hauer's species in ribbing had the greater whorl-thickness of *A. portisi*, whilst others were still more compressed; and the width of the umbilicus is equally variable. In the circumstances *Epacrochordiceras enode* is here taken to cover all the forms that conform to Hauer's figure (and to

Mojsovics's representation of *A. pustericum*, which differs merely in suture-line) and tend to lose costation with age. *A. (?) endrissi*, Arthaber (1914, p. 184, pl. xv, figs. 1a-c), has a more inflated, almost trigonal whorl-section.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *triodosus* zone. Alps; Bosnia; Montenegro; Greece; Roumania (?), Kashmir (?).

SPECIMENS :

C. 20373, 20376, 20444, 21231-5, 21236-43, 21258-60, 21262-5, 21270 (and duplicates). Stavljan, Volujak Mts., Bosnia. *V. Hawelka Coll.*, 1906-08.

C. 21267-9. Suha on the Sutjeska, Bosnia. *V. Hawelka Coll.*, 1906-08.

C. 30573-4, 30576-7, 30579, 30581-87. Mali Durmitor Mts., Montenegro. *V. Hawelka Coll.*, 1926.

Acrochordiceras (Epacrochordiceras) portisi, Martelli.

Plate XVIII, figs. 2a, b.

1906, p. 132, pl. vi, fig. 2.

DIAGNOSIS. Like *Epacrochordiceras enode*, but losing costation at a much earlier stage.

MEASUREMENTS :

Holotype (Martelli) . 46 . 54 . 39 . 19

REMARKS. It has already been mentioned that it is impossible to separate this species from the common *A. (E.) enode* on the basis of whorl-thickness, width of umbilicus and suture-line, unless we create many more such "species". It may, however, be restricted to the forms that differ from *A. (E.) enode* in losing their ribbing at an earlier stage. In the holotype the ribs seem to be already reduced at about 50 mm. diameter; in an example (C. 21253) of 82 mm. diameter, with about one quarter of the outer whorl belonging to the body-chamber, there is almost complete loss of ornamentation at the end. Since this example is more finely ribbed in the young; and retains a small umbilicus (13% of the diameter), it may belong to a new species, and it is interesting to note its superficial resemblance to the much more compressed "*Pinacoceras simplex*", Martelli (1906, p. 130, pl. v, fig. 23), with a suture-line approaching that of *Epacrochordiceras enode*. The suture-line of the figured example resembles that of *A. (E.) enode* much more than that of *A. haueri* ("*A. damesi*", Hauer, non Noetling), so

that definite identification with *A. portisi* is, perhaps, unadvisable. Since, however, there is scarcity of material, and individual variation is very considerable in all the Acrochordicerates, the restriction of Martelli's species as here suggested must be considered provisional.

HORIZON AND LOCALITIES. Lower Mesotrias, Anisian, *trindodus* zone. Balkans.

SPECIMENS :

C. 21253-4, 21261. Stavljan, Volujak Mts., Bosnia.

V. Hawelka Coll., 1906-08.

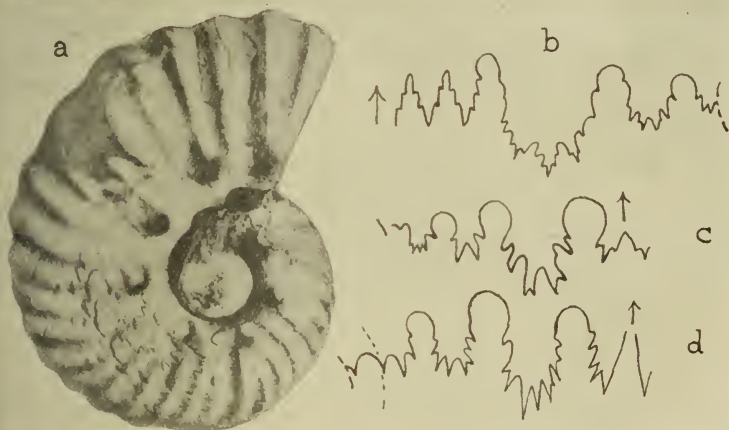


FIG. 139.—*Silesiacrochordiceras damesi* (Noetling). *a*, *b*, Side view and suture-line (wrongly restored, see p. 406) of holotype. Lower Wellenkalk, Germany. (After Philippi, in Frech, 1903, pl. i, figs. 7*a*, *b*.) *c*, *Acrochordiceras hyatti*, Meek. Suture-line. Middle Trias. Nevada. (After Hyatt and Smith, 1905, pl. xxiii, fig. 11.) *d*, *Acrochordiceras* (*Epacrochordiceras*) *pustericum*, Mojsisovics. Suture-line of an example (C. 13716) from the Middle Trias of the Gulf of Ismid, Anatolia.

Genus SILESIACROCHORDICERAS, Diener.

1916, p. 101.

GENOTYPE. *Acrochordiceras damesi*, Noetling, 1880, p. 334, pl. xv, fig. 1.

DIAGNOSIS. Like *Acrochordiceras* of the *A. hyatti-carolinæ* group, but with different, more subdivided, suture-line.

DISTRIBUTION. Middle Trias, Muschelkalk. Silesia.

REMARKS. Noetling's poorly preserved type was re-figured by Philippi (in Frech, 1903, pl. i, figs. 7*a*, *b*), and an arrow was added to the drawing of the suture-line, presumably to mark the position of the siphuncle or median line of the venter. This is almost certainly erroneous, and it seems that the first of the apparent adventitious saddles is in reality the external saddle of the opposite side, reduced by the compression or defective condition of the specimen to the size of the median saddle in the bifid external lobe. The suture-line, then, would be comparable to that of *A. haueri* (= *A. damesi*, Hauer, *non* Noetling), and this species and its allies would have to be referred to *Silesiacrochordiceras* rather than to *Acrochordiceras*, the *A. hyatti* group being characterized by its rounded saddles. Until, however, the uncertainty as regards the suture-line of *S. damesi* is removed, it seems preferable to adopt the classification here used.

g. Family BEYRICHITIDÆ, nov.

DIAGNOSIS. Rather involute, discoidal ammonites with falcoid, single, or bifurcating costæ. Suture-line ceratitic, with tendency to become sub-ammonitic and complex.

REMARKS. The primitive stock that produced the Paranoritidæ and the later Meekoceratids and Arctoceratids, as well as such more specialized, and therefore short-lived, offshoots as the Proptychitids and Procarnitids, again gave rise to a group of forms, here separated as Beyrichitidæ. They have been described as "transitional between the earlier Meekoceratids (*sensu lato*) and the later Ceratids, but their inter-relations are far too complex for them to be regarded as belonging all to one series, although the Paranoritids, Arctoceratids and Beyrichitids consecutively replace one another in time. Waagen, when creating the type-genus *Beyrichites*, placed it between *Proptychites* and *Ptychites*; but the Ptychitidæ, like Arcestidæ and Megaphyllitidæ, as already stated, may be more closely connected with the Paranannitids, and the resemblance of *Beyrichites* to the more flattened, adult *Ptychites* is (with Diener [1905], pp. 675, 792 and Arthaber [1914], p. 115) believed to be purely superficial. On the other hand, the convergence already noted towards certain *Acrochordiceras* is significant, and the tendency to develop Ceratitid ornamentation is similarly manifest in *Durgaites*; whilst such forms as *Ceratites murchisonianus* (de Koninck), Waagen, and *C. patella*, Waagen (the

former compared by this author to *Philippites erasmi*, Mojsisovics sp.), have been referred by v. Krafft and Diener (1915a, p. 85) to *Meekoceras* on the one hand, and *Sibirites* on the other. The widely different classifications that have been put forward indicate that all these families have a certain affinity with the ancestral forms of the Lower Trias that were formerly grouped in Meekoceratidæ. They are connected by transitions with the Ceratitidæ and other later stocks that are derived from the same primitive group, and therefore often produce similar offshoots.

Arthaber (1914, p. 117) included Toulas's numerous Ismid forms of "*Koninckites*", *Beyrichites* and *Nicomedites* in two species, which he referred to *Beyrichites*. The identity of these forms with this genus had already been suggested by Philipp and Diener; but the differences shown by the Ismid forms described below are sufficient for separation from the true *Beyrichites*. This is itself connected by all transitions with *Gymnotoceras* and the Ceratitids, although, as Diener stated, the earlier *Nicomedites* are equally close to *Hollandites*. Since in these and allied genera, such as *Philippites*, there is as yet no differentiation of the ventral area and no definite outer tubercle, it is convenient to separate them from the true *Ceratites*, and group them in the present family.

Genus NICOMEDITES, Toulas.

1896a, p. 5; 1896b, p. 150; 1896c, p. 138; 1896d, p. 180.

GENOTYPE. *Ceratites* (*Nicomedites*) *osmani*, Toulas, 1896d, p. 182, pl. xxii, figs. 6a, b.

DIAGNOSIS. Discoidal, flattened Beyrichitidæ, with more-or-less closed umbilicus, narrowly arched venter, and irregular subfalcate striation or costation. Suture-line sub-ceratitic, with saddles tending to become frilled.

DISTRIBUTION. Lower Meso-trias, Lower Anisian, Beyrichitan. Thuringia; Asia Minor.

REMARKS. Toulas's recognition, on Waagen's advice, of a genus *Nicomedites* was well justified; for it differs from *Beyrichites*, common at a higher level, in almost all details of whorl-shape and ornamentation, and especially in ontogenetic development; but the suture-lines are similar. *Osmanites*, based on the single species *Ceratites* (*Osmanites*) *abu-bekri*, Toulas, which was later united by Toulas himself with *Nicomedites*, does not seem entitled to generic separation. Whereas

in *Nicomedites* the subfalciradiate striae or ribs are most prominent at the middle of the side, *N. abu-bekri* is transitional to the Ceratitids in having the outer termination of the ribs more pronounced.

Neither can *Solimanites*, based on *Ceratites* [*Beyrichites*] *kazmaliensis*, Toula (1896a, p. 5, 1896d, p. 172, pl. xxi, figs. 8a, b), be separated from *Nicomedites*; nor can we accept the genus *Mohamedites*, created for *Ceratites* [*Beyrichites*] *fritschi*,

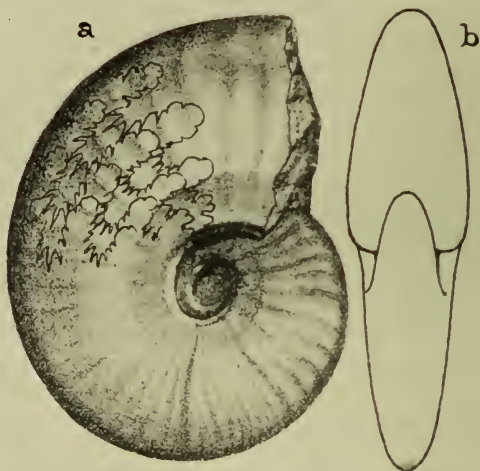


FIG. 140.—*Nicomedites osmani*, Toula. Side-view and diagrammatic sectional outline. Middle Trias. Gulf of Ismid, Anatolia. (a, after Toula, 1896d, pl. xxii, fig. 10a.)

Toula (1896a, p. 5, 1896d, p. 173, pl. xxi, figs. 7a, b). As Arthaber pointed out (1914, p. 115), all these forms, with others referred by Toula to Waagen's genus *Koninckites*, belong to a single genus; but since this is not identical with the true *Beyrichites*, it is necessary to retain Toula's name *Nicomedites* for the group. On the other hand, Arthaber separated from it a discoidal and comparatively smooth form as "*Aspidites*" *toulai* that again is connected by numerous transitions with the typical *Nicomedites*. It may be recalled in this connection that J. Perrin Smith, in 1914 (p. 116), had considered the forms of "*Beyrichites*" from Ismid to be direct and little modified

descendants of "*Aspidites*"; but Arthaber's species may be only the adult of a form like Toula's *Mohamedites fritschi*, included by the former author in "*Beyrichites*" *barbarossæ*. It is, therefore, now proposed to include the discoidal smooth forms, generally having more entire saddles, in a third species of *Nicomedites*, namely, *N. toulai* (Arthaber).

The auxiliary elements of the suture-lines of the Ismid forms are too variable to be used for subdivision, but the apparently new form here figured, and provisionally attached to *N. toulai*, differs from all the other forms in having the second lateral saddle at the middle of the whorl-side, and at least six more distinct auxiliary saddles running down to the umbilical suture. These characters suggest affinity with the earlier "*Aspidites*" (= *Clypeoceras*), but there seem also to be various forms with more subdivided saddles, and transitional to the contemporary *Nicomedites*. Moreover, the preservation of the Ismid material is not satisfactory, and for the present it does not seem advisable to create another new name for this single example.

Nicomedites osmani, Toula.

1896*d*, p. 182, pl. xxii, figs. 6*a*, *b*; Arthaber, 1914, p. 118; Diener, 1915*a*, p. 69 (*Beyrichites*).

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Nicomedites*. Whorl-sides flattened, venter narrowly arched, umbilical wall perpendicular. With faint subfalcoid striæ and costæ more pronounced on sides of outer whorl. Suture-line subceratitic, with high first lateral saddle (see fig. 140*a*, p. 408).

MEASUREMENTS :

Holotype (Toula, pl. xxii, fig. 6) .	61	·50	?	·19
C. 14070	88	·43	·30	·25

REMARKS. Arthaber selected the doubtful fragments represented in Toula's figs. 7 and 8 as typical of this species, but there can be no doubt, in view of Toula's remarks, that his example illustrated in figs. 6*a*, *b* must be accepted as holotype of the species. In this the costation is not so pronounced as in the two fragments, but no two examples are identical, and there are also numerous transitions to *N. barbarossæ*, with finer ornamentation. Arthaber may have been right in including Toula's *Koninckites saladini* and *K. hannibalis* in

the synonymy of the present species. In any case the examples in the Collection that had previously been referred to these two species, perhaps merely on account of their incompleteness, cannot be satisfactorily separated from *N. osmani*.

A number of fragments comparable to Toula's figs. 7 and 8, or even his *Danubites* (?) sp. (pl. xx, figs. 3, 4), may belong to new forms of *Nicomedites* or *Hollandites*.

HORIZON AND LOCALITIES. Lower Meso-trias, Lower Anisian. Asia Minor.

SPECIMENS :

- C. 14010-11, 14019, 14024, 14027, 15049, 15064 [14031, 15059, 15068, 15047-8, doubtful]. Dil-Iskelessi, Gulf of Ismid. *Dr. W. Endriss Coll.*, 1911.
C. 13721, 13738 [13731, 13761, 13715, 13718, 13729-30, doubtful]. Same locality. *Purchased*, 1910.

Nicomedites barbarossæ (Toula).

1896*d*, p. 177, pl. xxi, figs. 10*a-c* (*Koninckites*); Arthaber, 1914, p. 117, pl. xi, figs. 5-7; Diener, 1915*a*, p. 67 (*Beyrichites*).

DIAGNOSIS. Like *N. osmani*, but smaller, slenderer, and with finer and closer costation.

MEASUREMENTS :

Holotype (Toula, pl. xxi, fig. 10)	.	43	·53	·26	·13
C. 29571	.	42	·52	·29	·20 ?

REMARKS. A number of the specimens listed below agree with figs. 9 and 10 of Toula's pl. xxii (*N. osmani*, *partim*), which were referred by Arthaber to the present species. They are somewhat transitional, agreeing with *N. barbarossæ* in their more delicate ribbing, but with *N. osmani* in their wider umbilicus. Other examples agree more with the insufficiently characterized species figured by Toula as "*Koninckites libyssinus*", "*Beyrichites kazmaliensis*", "*B.*" *omari*, *Nicomedites mithridatis* and *N. prusiæ*. With Arthaber we may include them all in the present species, until more complete material enables us to define them on a safer basis than merely slight differences in the variable suture-line.

HORIZON AND LOCALITIES. Lower Meso-trias, Lower Anisian. Asia Minor.

SPECIMENS :

- C. 12400, 13726, 13728, 13732-3, 13735-7; C. 13846. Dil-Iskelessi, Gulf of Ismid. *Purchased*, 1909-11.

- C. 14018, 14021-23 ; 15061-3, 15065-6, 15069-74.** Same locality.
Dr. W. Endriss Coll., 1911.
- C. 29571.** Same locality. *Purchased, 1927.*

Nicomedites toulai (Arthaber).

1914, p. 114, pl. xi, figs. 3*a*, *b* (lectotype, 4*a*, *b*, text-fig. 4 [*Aspidites*]).

DIAGNOSIS. Like *N. barbarossæ*, but smooth, or with only faint striæ on septate portion, and still smaller umbilicus. Suture-line with five or six auxiliary lobes.

MEASUREMENTS :

Lectotype (Arthaber, pl. xi, fig. 3)	.	89	·50	·35	·15
Paratype (" " " " 4)	.	55	·53	·30	·13
C. 12408 (body-chamber)	.	109	·53	·30	·11

REMARKS. In the five typical examples listed below, the suture-line, by itself, would not suffice for separation from *N. barbarossæ*; but the body-chamber of *N. toulai* is entirely smooth. Arthaber's comparison of his species with *Koninckites yudishthira*, Diener (1897, p. 141, pl. xxii, fig. 1), and *K. septentrionalis*, Diener (1895*a*, p. 53, pl. i, figs. 1*a-c*), makes it probable that the small example here figured (Pl. XVIII, fig. 3*a*, *b*), although it has a suture-line more like that of "*Aspidites*" than have the typical examples, should also be attached to the present species. It may be found on examination of more complete material that Arthaber's name will fall in the synonymy of one of the rejected species created by Toula; but although that author figured various suture-lines that agree with that of Arthaber's "*Aspidites*" *toulai*, the specimen here figured is certainly distinct, and probably a new species.

HORIZON AND LOCALITIES. Lower Meso-trias, Lower Anisian. Asia Minor.

SPECIMENS :

- C. 12405-6.** Gulf of Ismid. *Purchased, 1909.*
- C. 13722, 13741-2.** Dil-Iskelessi, Gulf of Ismid. *Purchased, 1910.*
- ? **C. 15067.** Same locality. *Dr. W. Endriss Coll., 1911.*

Genus **HOLLANDITES**, Diener.

1905*a*, p. 677 ; 1905*b*, p. 776.

GENOTYPE. *Ammonites voiti*, Oppel, 1863, p. 276, pl. lxxvii, fig. 1.

DIAGNOSIS. More-or-less evolute, discoidal Beyrichtidæ, with arched or sub-tabulate venters, and sub-falcoid, often bifurcating ribs, with or without umbilical bullæ and only

traces of lateral or ventral tubercles. With a tendency to reduce the costation on the body-chamber to single coarse folds. Suture-line ceratitic.

DISTRIBUTION. Meso-trias, Anisian. Alps; Himalayas; Indo-China?; Japan; Nevada?

REMARKS. This genus must be restricted to the forms in

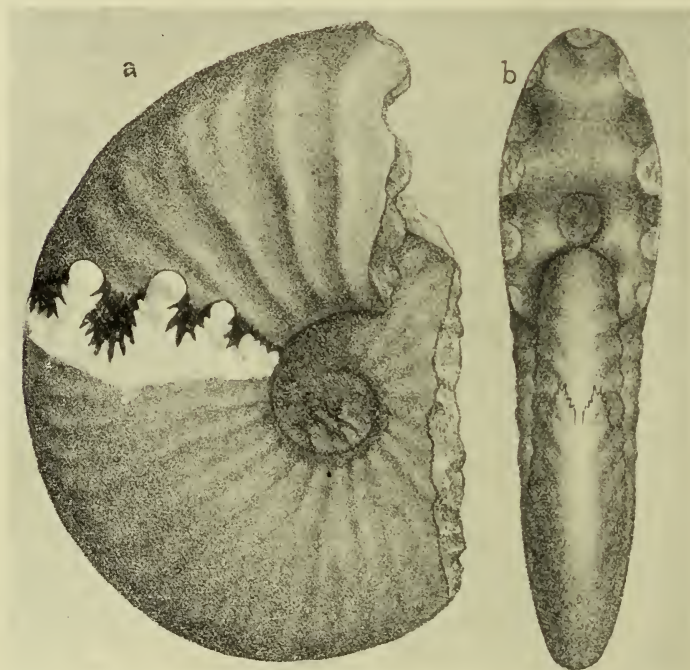


FIG. 141.—*Hollandites voiti* (Oppel). Side- and peripheral views of Oppel's type. Middle Trias. Kunzum Pass, Spiti, Himalayas. (After Diener, 1895*b*, pl. ii, figs. 2*a*, *b*.)

which there is as yet no pronounced tuberculation, and it probably does not include either the Eo-triassic *Ceratites pumilio*, v. Krafft and Diener (1909, p. 117, pl. xxvi, fig. 3), or the incompletely known Ladinian *C. zezianus*, Mojsisovics (1882, p. 44, pl. xxxvii, figs. 3, 4). There are transitions, however, to the group of *Ceratites binodosus* (= *Paraceratites*), with the lateral tubercle more definitely developed, and to *Gymnotoceras* with more pronounced and more falcoid ribbing and a tendency to carination. *Ceratites* (*Hollandites*) *organi*, J. Perrin Smith,

is mentioned below as being transitional from *Gymnotoceras* to *Frechites*, but it includes varieties that show considerable resemblance to such Himalayan species of *Hollandites* as those described later.

The writer does not agree with Diener (1925, p. 86) that *Hollandites* is richly represented in Nevada, and considers that even "*Hollandites* " *montis-bovis*, Smith, is more appropriately referred to *Gymnotoceras*.

Hollandites voiti (Oppel).

1863, p. 276, pl. lxxvii, fig. 1; Diener, 1915*a*, p. 98; 1925, p. 87, fig. 23.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Hollandites*. With whorl-sides flattened, and venter subtabulate or narrowly arched. With sub-falcoid ribs, first bifurcating, later single, and with a tendency to develop a lateral tubercle. Suture-line "brachyphyllic", sub-ceratic (see fig. 141, p. 412).

MEASUREMENTS :

Diener, 1895 <i>b</i> , p. 8 (No. I)	.	100	.	.45	.	.28	.	.22
" " " (" II)	.	83	.	.45	.	.25	.	.22

REMARKS. This species has been compared to the Alpine *Ceratites petersi*, Mojsisovics (1882, p. 27, pl. xi, fig. 10, pl. xl, fig. 14), but in the smaller size and acquisition of a nearly smooth body-chamber the Alpine form is closer to *Beyrichites* than to *Hollandites*. The only example in the Collection has a slightly wider umbilicus (27% of the diameter) than the specimens figured by Diener in 1895 (*b*, pl. ii, figs. 1, 2), and the ribbing is closer near the end (at over 100 mm.), which is still septate. This specimen is thus somewhat transitional to *H. ravana*, described below.

The resemblance of the inner whorls, figured by Diener in 1907 (pl. vii, figs. 3, 4) to those of *Beyrichites* (and *Gymnotoceras*) is to be expected in these closely related genera, but the Arcto-ceratic *Czekanowskites decipiens*, Mojsisovics sp. (see *supra*, p. 265), with its large external saddle, is only indirectly related.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trinosus* zone. Himalayas.

SPECIMENS :

C. 28551. North-east of Muth.

Coll. A. v. Krafft, determined by C. Diener.

Presented Geol Surv. India, 1926.

Hollandites ravana (Diener).

1895*b*, p. 10, pl. ii, figs. 5*a*, *b* (lectotype, 3, 4, 6); 1915*a*, p. 97.

DIAGNOSIS. Like *H. voiti*, but less involute and with more delicate ornamentation.

MEASUREMENTS :

Lectotype (Diener, 1895*b*, p. 10) . 86 .43 .28 .27

REMARKS. Diener (1907, p. 62) directed attention to the variability of this species, and in 1913 (p. 54) again recorded the existence of transitional forms, not only to *H. voiti*, described above, with a smaller umbilicus and coarser ribs, but also to *H. airavata*, with the umbilical tubercles more pronounced than the lateral ribs. The only example in the Collection, determined by A. v. Krafft as *Ceratites* cf. *ravana*, has a diameter of 115 mm.; two-thirds of the outer whorl belong to the body-chamber, but there is no sign of the typical, faint ribbing becoming coarser.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Himalayas.

SPECIMENS :

C. 28552. Near Muth, Spiti.

Coll. H. H. Hayden. Presented Geol. Surv. India, 1926.

Hollandites airavata (Diener).

1895*b*, p. 12, pl. iv, figs. 3*a-c*; 1915*a*, p. 96.

DIAGNOSIS. *Hollandites* resembling previous two species, but with the umbilical bullæ more pronounced than the faint lateral ribbing; there is a tendency to thicken the peripheral terminations of the costæ.

MEASUREMENTS :

Holotype (Diener, 1895*b*, pl. iv,
fig. 3) . 55 .49 .31 .16

REMARKS. Although incomplete, and only provisionally identified by A. v. Krafft with the species here described, the example listed below represents a typical body-chamber, just over half a whorl in length at a diameter of 58 mm. In possessing outer nodes—its principal distinguishing feature as compared with *H. ravana*—the present species resembles certain compressed *Paraceratites* of the *trinodosus*-group, but the ribbing is faint and there is no trace of a lateral tubercle. It

is clearly one of the transitional forms between the Beyrichitids and Ceratitids, as here restricted, but in spite of the presence of inner and outer tubercles, I agree with Diener in placing it in *Hollandites*.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Himalayas.

SPECIMENS :

C. 28558. South-east of Muth, Spiti.

Coll. H. H. Hayden. Presented Geol. Surv. India, 1926.

Hollandites hidimba (Diener).

1895*b*, p. 13, pl. iii, figs. 1*a*, *b* ; 1915*a*, p. 97.

DIAGNOSIS. Like *H. voiti*, but with wider umbilicus, broader periphery, and no trace of lateral tuberculation.

MEASUREMENTS :

Diener, 1895, p. 13 . 121 . .37 . .28 . .33

REMARKS. In the only (incomplete and worn) example of this species in the Collection, with one-third of a whorl of the body-chamber at a size corresponding to that of the holotype, the umbilicus is still wider (about 40% of the diameter). In spite of its poor preservation, however, this specimen may be attached to the present species, since *H. vyasa* (p. 417), with a similarly open umbilicus, differs considerably in ornamentation.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Himalayas.

SPECIMENS :

C. 28553. Between Dharma and Lissar Valleys.

Coll. La Touche, det. by C. Diener. Presented Geol. Surv. of India, 1926.

Hollandites visvakarma (Diener).

1895*b*, p. 16, pl. iv, fig. 2 ; 1915*a*, p. 98.

DIAGNOSIS. Like *H. hidimba*, but more compressed, with more slowly increasing whorls, and with more radial, straight and undivided ribs.

MEASUREMENTS :

Diener, 1895, p. 16 . 106 . .40 . .25 . .37

C. 28620 . . . (at 84) . .45 . .25 . .23

REMARKS. The opening out of the umbilicus in the adult is well shown in the example cited above (C. 28620), which is larger than Diener's type, and still septate at approximately 125 mm. diameter. Excentrumbilication thus is not confined to the body-chamber, as in many other comparable forms.

This species was described by Diener (1907, p. 64) as representing one of the simplest types of circumplicate ornamentation. The earlier whorls show great resemblance to the smooth early Beyrichitids of Asia Minor. The suture-line shows well-developed auxiliary saddles, but the subdivision of the almost entire principal saddles (at least in the example cited above) is at a considerably more primitive stage in the present species than in *H. voiti*, the genotype.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Himalayas.

SPECIMENS :

C. 28620. Poroo.

Coll. Middlemiss and Bion. Presented

Geol. Surv. India, 1926.

Hollandites dungara (Diener).

1895*b*, p. 15, pl. ii, fig. 2 ; 1915*a*, p. 97.

DIAGNOSIS. Like *H. hidimba*, but with more elliptical whorl-section and more curved ribs, which are provided with distinct lateral and ventral tubercles.

MEASUREMENTS :

Diener, 1895, p. 15	.	88	.	40	.	31	.	30
„ 1913, p. 55	.	85	.	38	.	30	.	32

REMARKS. In the development of distinct median and outer tubercles this species resembles the more involute *H. voiti*, with which it is connected by transitions. The only example in the Collection is still septate at 115 mm. diameter, but shows excentrumbilication, like the two species of *Hollandites* last described.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Himalayas.

SPECIMENS :

C. 28554. Lilang, Spiti.

Presented Geol. Surv. India, 1926.

Hollandites vyasa (Diener).

1895*b*, p. 19, pl. vi, fig. 2 (*non* figs. 1*a*, *b*) ; 1915*a*, p. 98.

DIAGNOSIS. Substenogyral, subleptogyral, sublatumbilicate *Hollandites*. Inner whorls compressed, with elliptical whorl-section, like typical *Hollandites* ; outer with uncoiling umbilicus and coarse straight ribs, almost tuberculate at their peripheral terminations. With wide, smooth venter and more rectangular section in adult. Suture-line similar to that of *H. voiti*.

MEASUREMENTS :

Holotype (Diener, 1895 <i>b</i> , p. 19)	. 170	.34	.26	.41
Diener (1907, p. 67, pl. vii, fig. 1)	. 167	.34	.27	.38
<i>Ibid.</i> (pl. vii, fig. 2)	. . . . . 61	.54	.25	.15

REMARKS. The dimensions well show the characteristic change in this species from involute, discoidal young to the loosely coiled, narrow-whorled adult. The larger example figured by Diener (1895*b*, pl. vi, figs. 1*a*, *b*) as *Ceratites vyasa* was separated by him (following A. v. Krafft's opinion) as a distinct form (*C. devasena*), and on account of its more coarsely ornamented inner whorls it was even excluded from the sub-genus *Hollandites*. The only example in the Collection determined by Prof. Diener himself is distorted by pressure, like the comparable Japanese *Hollandites japonicus* (Mojsisovics) figured by Diener (1915*c*, pl. iii, figs. 1*a*, *b*). The inner whorls, however, perhaps merely on account of this compression, resemble those of *Ceratites devasena* ; and although the form is more involute and more *Hollandites*-like than the specimen of *C. devasena* figured by Diener in 1907 (pl. iv, fig. 4), it suggests transition to the genus *Salterites* and the *Ceratitidæ* described below.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Himalayas.

SPECIMENS :

C. 28559. Jolinka, Byans.

Coll. F. H. Smith. Presented Geol. Surv. India, 1926.

Hollandites ? onustus (Oppel).

1863, p. 277, pl. lxxvii, fig. 2 (*Ammonites*) ; Diener, 1915*a*, p. 87 (*Ceratites* ?).

DIAGNOSIS. Like *H. hidimba*, but with ribs slightly coarser and more distant.

MEASUREMENTS :

	Whorl-height.	Thickness.
Oppel's type (<i>fide</i> Diener), smaller end	41 mm.	28 mm.
Salter and Blandford (1865), pl. vi, fig. 2 (" <i>Amm. blanfordi</i> "), larger end	39 ,,	28 ,,

REMARKS. The only example in the Collection, doubtfully referred to this species, is Salter and Blandford's type of their *Amm. blanfordi* (1865, p. 66, pl. vi, fig. 2), which had been already examined by Mojsisovics (*fide* Diener, 1895*b*, p. 19). Its affinity is with *Hollandites* like *H. hidimba*, above described, and *H. arjuna*, Diener sp. (1895*b*, pl. iv, figs. 1*a*, *b*), and there is no sign of tuberculation of the ribs. Oppel's type is still more distantly costate, but represents a fragment of a larger example, the measurements showing that the two fragments approximately fit on to each other. It might also be mentioned that, as in *Hollandites arjuna*, there is in the specimen now described a slight bi-convexity of the ribbing.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Himalayas.

SPECIMENS :

C. 4853. Raj-hoti, Himalayas.

Salter and Blandford's type, Strachey Coll.

Transferred Mus. Pract Geol., 1880.

Genus PHILIPPITES, Diener.

1905*b*, p. 773.

GENOTYPE. *Ceratites erasmi*, Mojsisovics, 1882, p. 43, pl. xl, fig. 13.

DIAGNOSIS. More-or-less involute, discoidal Beyrichitidæ, with narrowly arched venter and blunt ribs, prominent only near umbilical edge. Suture-line as in other Beyrichitids.

DISTRIBUTION. Meso-trias, Anisian. Alps ; Balkans ; Himalayas ; Nevada ?.

REMARKS. The three typical Alpine species, *P. erasmi* (Mojsisovics), *P. aster* (Hauer) and *P. tuberosus* (Arthaber) are very closely allied, but the Himalayan *Ceratites jolinkanus*, Diener (1907, pl. iv, fig. 6 ; pl. v, fig. 2), seems doubtful. Of the American forms described by J. Perrin Smith, *Ceratites (Philippites) argentarius* (1914, p. 107, pl. lxiii) is provisionally left in the present genus, but is probably only an extreme form of *Gymnotoceras* ; *C. (P.) lawsoni* (*ib.*, p. 108, pls. lvi, lvii) is transitional

from *Gymnotoceras wemplei*, described below, to the group of *Ceratites humboldtensis*, and therefore referred to *Frechites*; whilst the incompletely known *C. (P.) ransomei* (*ib.*, p. 108, pl. xcix, figs. 1-4) may be a more typical *Hollandites* than the other forms referred by J. Perrin Smith to that genus.

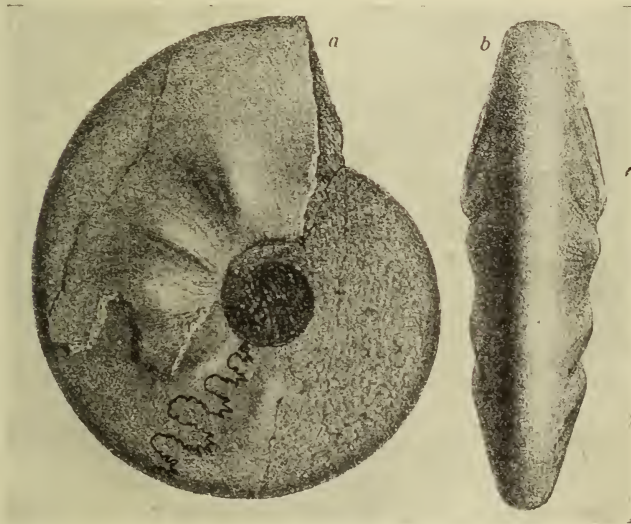


FIG. 142.—*Philippites erasmi* (Mojsisovics). Side- and peripheral views of holotype from the Middle Trias, *binodosus* zone, of the Pustertal, South Tyrol. (After Mojsisovics, 1882, pl. xl, figs. 13a, b.)

Philippites ? *argentarius*, Smith.

1914. *Ceratites (Philippites) argentarius*, Smith, p. 107, pl. lxxiii, figs. 1-3 (holotype), 4-14.

DIAGNOSIS. Platygyral, subpachygyral, subangustumbilicate ? *Philippites*, with convex sides, venter narrowly arched, occasionally subcarinate, and without ventral shoulders. Umbilical wall high and vertical. Indistinct ribbing, resembling that of *Beyrichites* or *Gymnotoceras*, soon degenerating into coarse pleats, about 12-14 to the whorl, and strongest near umbilical end. Suture-line ceratitic; saddles slightly "brachyphyllic."

MEASUREMENTS :

Holotype (Smith, p. 107)	.	60	.	50	.	42	.	18
C. 30879	.		.	50	.	52	.	20

REMARKS. It has already been mentioned that the American species attributed by J. Perrin Smith to *Philippites* seem to me much more closely allied to *Beyrichites* and *Gymnotoceras* than to the typical *Philippites erasmi*, Mojsisovics. The Alpine form is incompletely known, and its inner whorls, appearing entirely smooth, may have been incorrectly restored. Among the four metatypes of the species here described in the Collection, the largest (of 68 mm. diameter) could easily be referred to *Gymnotoceras meeki*, and is at most only a variety thereof; the other three, which again might be referred to three different "species", are closer to the type-figure; but although the periphery becomes narrowly arched, the close affinity with the typically more distinctly keeled *Gymnotoceras* is evident.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trindodus* zone. Nevada.

SPECIMENS :

C. 30879-81, 30889. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada (*ex* J. P. Smith Coll.). Presented Dr. C. T. Trechmann, 1920.

Genus BEYRICHITES, Waagen.

1895, p. 160; Diener, 1915*a*, p. 67; Kraus, 1916, p. 295 (?); Kutassy, 1933, p. 436.

GENOTYPE. *Ammonites reuttensis*, Beyrich, 1867, p. 113, pl. i, fig. 4.

DIAGNOSIS. More or less involute, discoidal Beyrichitidæ, with narrowly arched venter and sigmoidal, often bifurcating costæ in young, tending to disappear or become modified on the outer whorls. Ribbing non-tuberculate in typical forms (sub-genus *Beyrichites* s.s.). Suture-line subammonitic.

DISTRIBUTION. Lower Meso-trias, Anisian (and Ladinian?). Alps; Balkans; Himalayas; Japan; Nevada.

REMARKS. *Beyrichites* is believed to be an offshoot of the Ceratitidæ in the larger sense, if not through *Gymnotoceras*, as Prof. J. Perrin Smith (1914, p. 115) suggested, at least parallel to it. Forms like *Meekoceras affine*, Mojsisovics (1886, p. 86, pl. xi, figs. 17*a*, *b*), referred by Diener to *Beyrichites*, are morphologically intermediate to *Arctoceras*; but this itself is probably not the ancestor of Beyrichitidæ, and the time gap between

the *Arctoceratids* and the typical *Beyrichites* is considerable. In Diener's interpretation, *Beyrichites* includes not only *Nicomedites*, but also such forms as *Beneckeia cognata*, Wagner (1891, p. 898, pl. xlix, fig. 6), refigured by Philippi (1903, text-fig. c on p. 38) as *Ptychites* (*Beyrichites*) *cognatus*, besides species previously described as *Koninckites*, *Meekoceras*, and even



FIG. 143.—*Beyrichites khanikofi* (Oppel). Side- and peripheral views and suture-line of one of Oppel's syntypes in Munich. Middle Trias. Shangra, Hundes, Himalayas. (After Diener, 1895*b*, pl. viii, figs. 3*a-c*.)

Pinacoceras. Definite generic identification in some cases may be difficult, but *Beyrichites*, as here restricted, is characterized by its *Gymnotoceras*-like inner whorls, and the absence, or at most only the indication of, a keel. The tuberculate form described below as *B. bipunctatus*, as well as some related species with resemblance both to *Gymnitids* and *Ceratitids*, are provisionally referred to the sub-genus *Gangadharites*.

Sub-genus **BEYRICHITES** s.s.

DIAGNOSIS. See generic diagnosis above. Non-tuberculate forms only.

Beyrichites rotelliformis (Meek).

1877, p. 111, pl. x, figs. 9, 9a (*Gymnotoceras*); Smith, 1914, p. 118; Diener, 1915a, p. 70.

DIAGNOSIS. Platygyral, subleptogyral, angustumbilicate *Beyrichites*, with whorl-sides flattened, vertical umbilical wall, and venter narrowly arched. With sigmoidal ribs, in the young strongest on the side, and obsolete on venter; in the adult indistinct laterally, but pronounced at the peripheral end. Suture-line ceratitic, with saddles becoming indented.

MEASUREMENTS:

Smith, 1914, pl. xxxi, figs. 5, 6	37	.	·52	.	·33	.	·16
„ „ pl. xci, fig. 1	60	.	·53	.	?	.	·11
C. 21885	60	.	·53	.	·33	.	·13

REMARKS. As Prof. J. Perrin Smith pointed out, this species is exceedingly variable, and whilst some specimens are strongly ornamented in the young, and nearly smooth in the adult, others show a reverse development. There is also variability in the whorl-thickness, but this is always greater than in *B. falciformis*, and especially *B. tenuis*, and less than in *B. dunni*; and the ribbing is always more pronounced than in *B. osmonti*. In addition to the examples enumerated below, the Collection includes a large number of immature specimens and undeveloped material from the Middle Trias of Nevada, including various species of *Beyrichites* as well as *Gymnotoceras*.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Nevada.

SPECIMENS:

C. 21885-6, 30886-8. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada. (*Ex* J. Perrin Smith Coll.). Presented Dr. C. T. Trechmann, 1920.

C. 30589-93. "Bottom Bed", same locality.

P. Train Coll., 1927.

C. 30600-10, 30652-4, 30882-5. Out of loose blocks.

Same locality and collection.

C. 32437. Same locality. Dr. H. G. Schenk, 1929.

Beyrichites falciformis, Smith.

1914, p. 116, pl. xci, figs. 11-13 (holotype), pl. xcii, figs. 1-8.

DIAGNOSIS. Like *B. rotelliformis*, but with more sharply defined ribs in the adolescent stage, as in *Gymnotoceras*.

MEASUREMENTS :

Holotype	70	. . .	.50	. . .	.31	. . .	.17
C. 21884 (metatype)	48	. . .	.56	. . .	.32	. . .	.13

REMARKS. In addition to the typically sharper ribbing, a narrower ventral area with tendency to fastigation and a more compressed whorl-shape distinguish this species from *B. rotelliformis*, with which, however, it is connected by numerous transitions, including a number of the examples listed below, and probably other, unclassified, immature material. *B. tenuis*, Smith (1914, p. 119, pl. xxxii, figs. 1-6; pl. lxxxix, figs. 15-20) is still more compressed, and has weaker ornamentation.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Nevada.

SPECIMENS :

C. 21883-4, 30809. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada.

(*Ex* J. Perrin Smith Coll. Presented
Dr. C. T. Trechmann, 1920.

C. 30623-33. "Bottom Bed", same locality.

P. Train Coll., 1927.

C. 30634-9, 30875-8. Out of loose blocks. *Same locality and coll.*

Beyrichites dunni, Smith.

1914, p. 116, pl. xxxii, figs. 7, 8 (holotype), 9-12.

DIAGNOSIS. Like *B. rotelliformis*, but less compressed and with more robust ornamentation in the young.

MEASUREMENTS :

Holotype	63	. . .	.51	. . .	.36	. . .	.18
C. 27334	48	. . .	.52	. . .	.37	. . .	.17

REMARKS. This species is not well defined, and appears to be based merely on the more inflated varieties of *B. rotelliformis*. Prof. J. Perrin Smith gave the width of the umbilicus as one-fifth of the diameter, and stated that this species was distinguished from *B. rotelliformis* by its weaker ribs. The figure of his holotype shows just the reverse, the costation of the earlier

whorls being as coarse as it is in *Gymnotoceras*. The larger size of *B. dunni*, again, seems a doubtful characteristic. In any case the specimens listed below and referred to the present species are connected with *B. rotelliformis* by many transitions in various directions, and do not form a homogeneous assemblage. *B. osmonti*, Smith (1914, p. 117, pl. xxxi, figs. 7, 8, etc.), with complete lack of ornamentation, is also more compressed than *B. dunni*.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Nevada.

SPECIMENS :

C. 27334. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada. *Obtained in exchange*, 1926.

C. 30620-2. "Bottom Bed", same locality.

P. Train Coll., 1927.

C. 30611-19, C. 30655-6. Out of loose blocks.

Same locality and collection.

Beyrichites khanikofi (Oppel).

1863, p. 275, pl. lxxvi, fig. 4 (*Ammonites*); Diener, 1915a, p. 68.

DIAGNOSIS. Platygyral, subleptogyral, angustumbilicate *Beyrichites*. Whorl-sides flattened, with high and perpendicular umbilical wall, but rounded edge; venter narrowly arched. With faint sigmoidal ribs on the inner whorls, degenerating into distant folds near the venter on the outer whorl. Suture-line sub-ceratic, with saddles tending to be indented to the tops; two lateral and five auxiliary lobes.

MEASUREMENTS :

Holotype (<i>fide</i> Diener, 1895 <i>b</i> , p. 41)	68	·54	·31	·10
Diener, 1895 <i>b</i> , pl. viii, fig. 3	. 62	·58	·32	·14
„ „ pl. ix, fig. 1	. 100	·52	·27	·14

REMARKS. Two typical examples in the Collection agree with Diener's fig. 1 (1895*b*, pl. ix), the measurements of which are here listed. The larger, at about 120 mm. diameter, shows a third of a whorl of body-chamber and very pronounced excentrumbilication. The smaller, at only 85 mm. diameter, has half a whorl of body-chamber, but the umbilicus remains closed. Diener pointed out that in the more typical forms the proportions are slightly different; he was probably right in including all the variations in one species, but not the tuberculate ones. The differences, chiefly in the suture-line, between the species

here described and *B. reuttensis*, Mojsisovics sp. (1882, p. 215, pl. ix, figs. 1-3), are very slight. If "*Meekoceras*" *cadoricum*, Mojsisovics (1882, p. 215, pl. xii, figs. 9a-c), from the *binodosus* zone, is a forerunner of the typical later *Beyrichites*, as appears probable, the convergence of the present form to certain Gymnitids on the one hand, and to Ptychitids on the other, is purely accidental.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trinosus* zone. Himalayas.

SPECIMENS :

C. 28632. Shalshal Cliff, Rimkin Paiar Encamping Ground.

Coll. C. Diener. Presented Geol. Surv. India, 1926.

C. 28633. Near Muth, Spiti. Coll. H. H. Hayden.

Presented Geol. Surv. India, 1926.

Sub-genus **GANGADHARITES**, Diener.

1916, p. 101.

SUB-GENOTYPE. *Meekoceras gangadhara*, Diener, 1895, p. 49, pl. ix, figs. 4a-c.

DIAGNOSIS. *Beyrichites* of flat, discoidal shape and with small umbilicus and a few additional auxiliary lobes. Tubercles at the middle of the side and sometimes also at the outer ends of some or all of the last few ribs on the body-chamber.

DISTRIBUTION. Anisian. Himalayas.

REMARKS. Diener did not define this sub-genus, and considered *M. gangadhara* to be characterized by what he called a "very long, serrated, umbilical lobe". The sub-genus, however, is here adopted rather on account of the tuberculation of the body-chamber, which is a feature unknown in *Beyrichites* s.s., but suggestive of *Paraceratites*. The resemblance to the more discoidal Gymnitids, like *Epigymnites*, is accidental, for *Gangadharites* is clearly connected with *Beyrichites* by extreme varieties of *B. khanikofi* (Oppel).

Beyrichites (Gangadharites) bipunctatus, sp. nov.

Plate XVII, figs. 2a, b.

1895. *Meekoceras khanikofi* (Oppel), Diener, var., p. 42, pl. ix, fig. 2 only.

DIAGNOSIS. Like *Beyrichites khanikofi* (Oppel), but with lateral and ventral tubercles on the ribs of the body-chamber, as in

Paraceratites. Both ribs and tubercles more conspicuous than in *B. (G.) gangadhara*.

MEASUREMENTS :

Holotype (C. 26261)	. 63	. 52	. 29	. 12
Diener, pl. ix, fig. 2	. 69	. 51	. 32	. 13

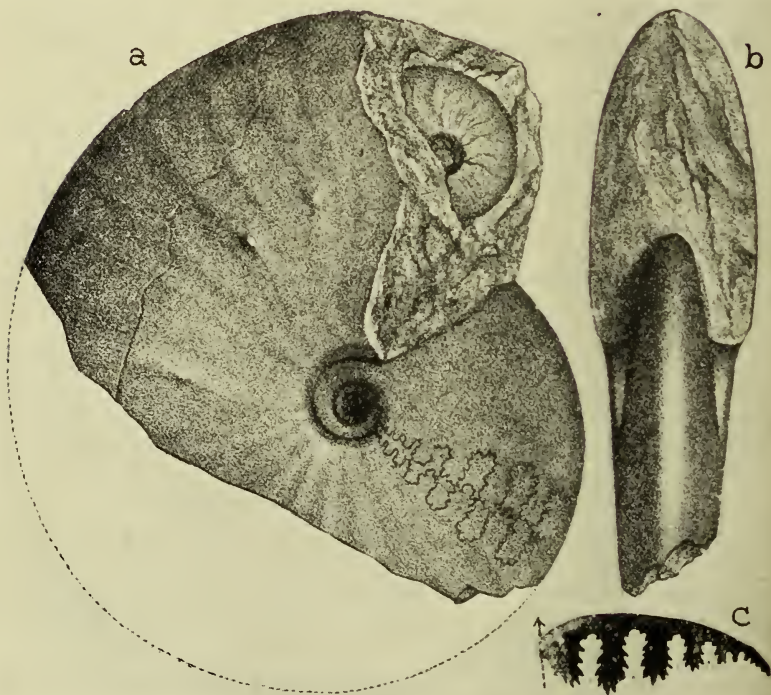


FIG. 144.—*Beyrichites (Gangadharites) gangadhara*, Diener. Anisian. Shalshal Cliff, Himalayas. (After Diener, 1895b, pl. ix, figs. 4a-c.)

REMARKS. Diener considered the present form provisionally as a variety of *B. khanikofi*, but his fragmentary example showed only lateral tubercles “in the middle portion of the sides, near the beginning of the outer, strongly developed part of the falciform folds”. The holotype, here figured, with half a whorl of body-chamber, is more complete, and has not only the same elliptical shape as the example figured by Diener, but about four distinct outer tubercles at the ventro-lateral

shoulders. The whorl-section thus agrees with that of *Paraceratites* of the *binodosus* type, which also has no umbilical tubercle, but the involute and compressed earlier whorls with their outer, *Oppelia*-like, crescents are, of course, quite different from those of *Paraceratites*.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Himalayas.

SPECIMENS :

C. 26261. [Spiti ?.]

Purchased, 1926.

Genus GYMNOTOCERAS, Hyatt.

In Meek, 1877, p. 110 ; Smith, 1914, p. 109 (as sub-genus).

GENOTYPE. *Ammonites blakei*, Gabb, 1864, p. 24, pl. iv, figs. 14, 15.

DIAGNOSIS. More-or-less involute, rapidly increasing, robust Beyrichitidæ, with sub-tabulate to sub-carinate periphery and strong sigmoidal, single or bifurcating costation. Suture-line sub-ceratitic, with weakly "brachyphyllic" saddles.

DISTRIBUTION. Lower Meso-trias, Anisian. Spitsbergen ; Nevada ; Japan ; Himalayas (?).

REMARKS. The American forms of *Gymnotoceras* are as closely allied to some of the genera described below among the Ceratitidæ, *e. g.* *Paraceratites*, as they are to the Beyrichitids ; they are thus transitional to the Ceratitidæ. The genus is here taken to include transitional forms like *Ceratites* (*Hollandites*) *montis-bovis*, Smith (1914, p. 105, pl. lviii) ; but Diener's doubtful *Ceratites* nov. sp. ind., of the group of *C. geminati* (1895b, p. 28, pl. v, fig. 3), with its (apparent ?) keel, is not a *Gymnotoceras*, in spite of its auriculæ. The Arctic forms are probably more primitive, and may even be derived from the stock that gave rise also to the "*Ceratites obsoleti*" (*supra*, p. 360).

Gymnotoceras blakei (Gabb).

1864, p. 24, pl. iv, figs. 14, 15 (*Ammonites*) ; Smith, 1914, p. 109, pl. iii, figs. 10-23 ; pl. xvi, figs. 8-10 ; pl. lxv, figs. 14-19 ; pl. lxvi, figs. 1-9 ; Diener, 1915a, p. 94.

DIAGNOSIS. Platygyral, subleptogyral, subangustumbilicate *Gymnotoceras*, with whorl-sides flattened, slightly convex and venter sub-carinate, arched, with indistinct shoulders. Sharp sigmoidal bifurcating costæ, non-tuberculate, sharply projected at ventro-lateral edges. Suture-line sub-ceratitic (see fig. 145c).

MEASUREMENTS :

Smith, 1914, pl. lxxv, figs. 14, 15 .	64	·50	·34	·17
C. 30658	42	·55	·34	·17

REMARKS. This species is undoubtedly very closely allied to *G. meeki* (Mojsisovics), and especially to *G. russelli* and



FIG. 145.—*Gymnotoceras blakei* (Gabb). Side- and peripheral views and suture-line (enlarged $\times 2$) of examples from the Middle Trias, American Canyon, Nevada. (After Smith, 1914, pl. lxxv, figs. 14, 15, 19.)

G. beckeri, Smith, which had at first been included by their author in a more comprehensive *G. blakei*. Prof. J. Perrin Smith insisted on having found no transitions between these "species"; but among the large, unworked Nevada material in the Collection there are many passage forms, although mostly immature, and therefore difficult to separate specifically. The Spitsbergen *G. falcatum* and *G. arcticum* (Mojsisovics) may be more primitive forms of the same group, to which belong

G. blakei and the other American forms; but through *G. laqueatum* (Lindström) the Arctic species are connected with the group of *G. nathorsti* and *G. geminatum* (Mojsisovics), and the striking convergence of these towards certain Sibiritids and Stephanitids is another indication of the polyphyletic character of the original "Ceratitidæ".

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Nevada.

SPECIMENS :

C. 30658. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada.

Ex J. Perrin Smith Coll. Presented
Dr. C. T. Trechmann, 1920.

C. 30640-51. "Bottom Bed" and "loose". Same locality.

P. Train Coll., 1927.

The Collection also includes a large number of immature *Gymnotoceras* (e. g. C. 30675-83), including young of the present, as well as of other related, species.

Gymnotoceras russelli, Smith.

1914, p. 111, pl. iii, figs. 1-3, 6; pl. lxxvii, figs. 1-15.

DIAGNOSIS. Like *G. blakei*, but less compressed, with stronger ribs and more distinct ventro-lateral "shoulders".

MEASUREMENTS :

Holotype (Smith, pl. iii, figs. 1-3)	46	·49	·27	·22
C. 21941	48	·48	·37	·25

REMARKS. This form, said to be by far the commonest species of *Gymnotoceras* in the Middle Trias of Nevada, was first included by Hyatt and Smith (1905, p. 173, pl. xxii, figs. 1-3, 6) in *G. blakei*. Prof. J. Perrin Smith, in 1914, stated that he had not found any intergradations between the two species, but an attempt to classify the hundreds of specimens in the Train Collection, recently received, has shown that the specific distinctions are by no means sharply defined. *G. russelli* is one of the numerous intermediate forms between the compressed and finely ornamented *G. blakei* and the more inflated, coarsely ribbed *G. meeki*. Nor can the equally transitional *G. beckeri*, with the ventro-lateral edges or shoulders slightly less developed, and with somewhat finer costation, be satisfactorily separated from *G. russelli*.

Some examples with the primary ribs elevated into an inner

tubercle are intermediate to forms like *Ceratites* (*Gymnotoceras*) *wemplei*, Smith.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Nevada, U.S.A.

SPECIMENS :

C. 21941-2, 30697-8. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada.

Ex *J. Perrin Smith Coll.* Presented

Dr. C. T. Trechmann, 1920.

C. 27331. Same locality. *In exchange*, 1926.

C. 30690-96, 30810-28 (and unsorted immature examples).

Same locality. *P. Train Coll.*, 1927.

C. 32434. Same locality. *Dr. H. G. Schenck*, 1929.

***Gymnotoceras meeki* (Mojsisovics).**

1888, p. 168 (*Ceratites*); Smith, 1914, p. 111, pl. xiv, figs. 10a-c; pl. lxix, figs. 1-19, based on *Gymnotoceras blakei* [non Gabb], Meek, 1877, pl. x, figs. 10, 10a.

DIAGNOSIS. Like *G. blakei* and *G. russelli*, but more inflated and with still coarser ribs.

MEASUREMENTS :

Smith, 1914, pl. lxix, figs. 1, 2 . 49 .46 .38 .21

C. 30660 60 .50 .40 .20

REMARKS. This common and variable form is connected by transitions with the typically less coarsely-ribbed *G. russelli*, and like the latter, with the more tuberculate forms of the type of *G. wemplei*, Smith, and hence even with *Frechites humboldtensis* (Hyatt and Smith). In a number of examples, the blunt ribbing of the outer whorl tends to become obsolete, and there is, then, resemblance to species of *Beyrichites* (compare Smith, 1914, pl. xci, figs. 11, 12), whilst the indistinctness of the keel in others produces forms that cannot satisfactorily be separated from *Ceratites* (*Hollandites*) *organi*, Smith (*e.g. loc. cit.*, pl. lv, figs. 5, 6). The heterogeneous assemblages of forms included by Smith in his "species" of *Hollandites*, *Philippites*, etc., make it appear probable that he greatly over-rated the value, for phylogenetic purposes, of the rate of development of the keel. This is extremely variable; the keel probably appeared cœnogenetically in the young of certain *Gymnotoceras*, and cannot be adduced as proof of the derivation of *Hollandites*, *Philippites*, etc., from a keeled ancestor. It is interesting to note in this connection that among five specimens in Dr. Trechmann's

collection, sent by Prof. J. P. Smith as *Hollandites organi*, three are now included in the present species and two are taken to belong to *Gymnotoceras wemplei*. Many of the examples listed below might have been referred to "*Hollandites*" *montis-bovis*, Smith, but are probably only varieties, transitional to *G. russelli*.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Nevada, U.S.A.

SPECIMENS :

C. 30660-4, 30699-701, 30808. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada.
Ex *J. Perrin Smith Coll.* Presented *Dr. C. T. Trechmann*, 1920.

C. 27330, 27332, 27343. Same locality. Purchased, 1926.

C. 30657, 30665-72, 30684-9, 30829-70, 31301. Same locality.
P. Train Coll., 1927.

C. 32433. Same locality. *Dr. H. G. Schenck*, 1929.

***Gymnotoceras wemplei*, Smith.**

1914, p. 113, pl. lxxviii, figs. 1-3 (holotype), 4-9.

DIAGNOSIS. Like *G. meeki*, but with a stronger development of lateral and outer tubercles than in that form or in other American *Gymnotoceras*.

MEASUREMENTS :

Holotype (Smith, 1914, p. 113)	.	77	·47	·36 [·40 ?]	·25
C. 30702	.	73	·49	·44	·21

REMARKS. The two examples here listed were sent by Prof. J. Perrin Smith to Dr. Trechmann (who presented them to the Museum) labelled as *Ceratites (Hollandites) organi*, Smith; but the type of that form is characterized by its flattened periphery and absence of a keel. The numerous American species of *Paraceratites* are very closely inter-allied, and there seem to be many transitions from *Gymnotoceras wemplei* to the group of *Frechites humboldtensis*, discussed below.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Nevada, U.S.A.

SPECIMENS :

C. 30702-3. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada. Ex *J. Perrin Smith Coll.*
Presented *Dr. C. T. Trechmann*, 1920.

C. 30871-4. Same locality. *P. Train Coll.*, 1927.

Gymnotoceras laqueatum (Lindström).

1865, p. 5, pl. ii, figs. 3, 4 (*Ceratites*); Diener, 1915a, p. 94; Spath, 1921, p. 349.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Gymnotoceras*. Whorl-section compressed, sub-rectangular, with almost parallel sides, and distinct umbilical and ventrolateral shoulders; periphery subtabulate, with blunt median keel. Ribs falcoid, tuberculate on inner area of chambered part, then irregularly branching and terminating in faint ventrolateral thickenings, projected forwards, with occasional auriculæ. Suture-line ceratitic, with saddles only slightly denticulated.

MEASUREMENTS :

Mojsisovics, 1886, p. 53 . 50 . 50 . 32 . 21

REMARKS. The simple suture-line with the saddles far less frilled than in the American species above described, and with the first auxiliary lobe at the umbilical edge, in addition to the tuberculate inner whorls, makes it doubtful whether the Arctic forms are as closely related to the genotype of *Gymnotoceras* as is generally assumed. There is before me an example (B.M., C. 37219) of what I take to be "*Ceratites*" *vega*, Öberg (1877, p. 14, pl. iv, fig. 2), of 100 mm. diameter, and showing about three-quarters of a whorl of body-chamber. This seems to connect *G. laqueatum* with the group of *Keyserlingites midden-dorffi* (Keyserling); and the similarity in development of the form figured in fig. 119 (p. 355) with such Arctic *Gymnotoceras* as *G. nathorsti*, Mojsisovics sp. (1886, p. 53, pl. ix, figs. 3a-c), is striking, the keel being a more or less transient feature in the latter group.

Most of the Spitsbergen examples listed below are crushed, and specific separation from the similar impressions of the more finely rubbed *G. geminatum*, or even other Ceratitids, is not always possible. The example previously (1921, p. 349) recorded as *G. falcatum* (C. 21731), on account of its larger umbilicus, is now also attached to *G. laqueatum*.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Spitsbergen.

SPECIMENS :

C. 13842. Sassen Bay. Presented Walter Child, Esq., 1911.

C. 21731, 27005, 27007, 27014. Trident, Sassendal (E, basement Bed). Prof. J. W. Gregory Coll., presented 1896.

C. 26986-7, 26989-90, 26993-4, 27015-16, 27264. Trident, West Trident and Sassen Bay.

Prof. E. J. Garwood Coll., presented 1896.

C. 37219. Ice Fjord.

R. W. Segnit Coll., 1921.

Gymnotoceras geminatum (Mojsisovics).

1886, p. 49, pl. ix, figs. 7a-b (*typus*), 13, 14 (*Ceratites*); Diener, 1915a, p. 94; Spath, 1921, p. 349; Frebold, 1929, p. 303.

DIAGNOSIS. Like *G. laqueatum*, but more evolute, and with finer and closer costation.

MEASUREMENTS :

Mojsisovics, 1886, p. 50 . 22·5 . 42 . 40 . 29

REMARKS. There are numerous crushed examples comparable to Mojsisovics's (1886, pl. ix, figs. 13 and 14) two Spitsbergen impressions, but their separation from other forms, even "*Danubites*" and other genera, is often impossible. The closely allied *G. arcticum* and *G. falcatum*, Mojsisovics sp. (1886, pl. ix, figs. 9 and 11), differ chiefly in their smaller umbilicus, but also could not be distinguished in crushed individuals.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian. Spitsbergen.

SPECIMENS :

C. 27000-4, 27006, 27008-13, 27272. Trident, Sassendal, and Sassen Bay. *Prof. J. W. Gregory Coll., presented 1896.*

C. 26988, 26991-2, 26995-7. Trident and West Trident, Sassendal. *Prof. E. J. Garwood Coll., presented 1896.*

C. 22019-23. Van Keulen's Bay, Bell Sound.

W. J. Reynolds Coll., presented 1920.

C. 22029-30. West of "Fortress", near Cape Staratshin, Ice Fjord. *Same Coll.*

H. Family CERATITIDÆ, Mojsisovics emend.

DIAGNOSIS. More-or-less evolute, generally highly ornamented (*i. e.* bi-, tri- or multi-tuberculate) ammonoids, with tabulate to sub-carinate peripheries, and ceratitic suture-lines with entire saddles.

REMARKS. Arthaber, who discussed this family in 1914 (p. 119), was probably right in reducing the numerous forms of

the Alpine, Himalayan and Pacific provinces to one single (*binodosus-trinodosus*) type, and in accepting Philippi's description of the well-known *Ceratites* of the Germanic province as degenerate derivatives of the widespread Mediterranean types. The writer admits that the Nevada *Gymnotoceras* merges by means of various passage forms into the Mediterranean *trinodosus* type (= *Paraceratites*), and that *Hollandites* is a development parallel with the semi-ornate Ceratitids of the Alpine province. These two genera, however, are here included in the last family, and not in the restricted Ceratitidæ, because *Gymnotoceras* is also connected by transitions with *Beyrichites*, and because *Hollandites* is typically non-tuberculate. The mere fact that we have left in the one genus *Gymnotoceras* two groups that may be derived from different ancestors will show that, even in the restricted sense, the families Beyrichitidæ and Ceratitidæ cannot yet be claimed to be monophyletic, and that their separation is prompted by systematic convenience.

Genus PARACERATITES, Hyatt.

1900, p. 559.

GENOTYPE. *Ceratites elegans*, Mojsisovics, 1882, p. 31, pl. ix, figs. 5a-d.

DIAGNOSIS. Rather involute, often compressed, discoidal Ceratitidæ, with subcarinate periphery and typically trituberculate, subdividing costation, which, however, may become very feeble. Suture-line with saddles less entire than in true *Ceratites*.

RANGE. Meso-trias, Anisian. Alps; Silesia; Balkans; Asia Minor; Himalayas; Japan; California; Nevada.

REMARKS. Hyatt indicated the type, *Ceratites elegans*, and figured *P. trinodosus* (Mojsisovics), which, as Arthaber (1914, p. 123) has shown, is intimately connected with *P. binodosus* (Mojsisovics). We are thus justified in accepting *Paraceratites* to comprise not only J. P. Smith's (1914, pp. 78, 79) sub-groups of *Ceratites elegans* and *C. trinodosus*, Mojsisovics, but also the group of *C. kingi*, Smith. The first two groups of American "nodosi" listed by Smith, namely the groups of *Ceratites rotuloides*, Smith, and *C. occidentalis*, Smith, with inner whorls like *Gymnotoceras* and outer like *Semiornites*, are discussed below under *Frechites*.

Paraceratites binodosus (Hauer).

1850, p. 114, pl. xix, figs. 1, 4; Arthaber, 1914, p. 121; Diener, 1915a, p. 79 (*Ceratites*).

DIAGNOSIS. Subplatygyral to platygyral, subleptogyral, subangustumbilicate *Paraceratites*. Whorl-sides flattened, venter subtabulate to arched, ventro-lateral and umbilical edges distinct, with blunt, indistinctly bifurcating and slightly bent ribs, degenerating with age, and provided with lateral and peripheral tubercles. Suture-line ceratitic, with external lobe occupying the whole of the ventral area, and with only apexes of saddles entire.



FIG. 146.—*Paraceratites trinodosus* (Mojsisovics). Side- and two peripheral views of a specimen from the Middle Trias of the American Canyon, Nevada. (After Smith, 1914, pl. lii, figs. 12-14.)

MEASUREMENTS :

Mojsisovics, 1882, p. 20	.	.	52	·48	·30	·21
C. 14013	.	.	70	·42	·30	·23
Var. <i>anguste-umbilicata</i> (Mojsisovics, 1882, pl. xi, fig. 5)	.	.	64	·53	·27	·15

REMARKS. Of the Dil-Iskelessi specimens in the Collection, one (C. 13727) agrees with the typical figures in Mojsisovics (1882, pl. xi, figs. 1-4) and with Arthaber's (1914, pl. xii, fig. 1) Anatolian "variety", whilst a second (C. 13739) is worn, and could not thus be definitely distinguished from such similar species as *P. abichi* Mojsisovics sp. (1882, p. 21, pl. xi,

The Schreyer Alm example listed below is transitional to *P. abichi*, Mojsisovics sp. (1882, p. 21, pl. xi, figs. 8a, b; pl. xxii, fig. 6; pl. xxxiii, fig. 7).

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *triodosus* zone. Alps; Balkans; Asia Minor; Himalayas (?); Nevada (?).

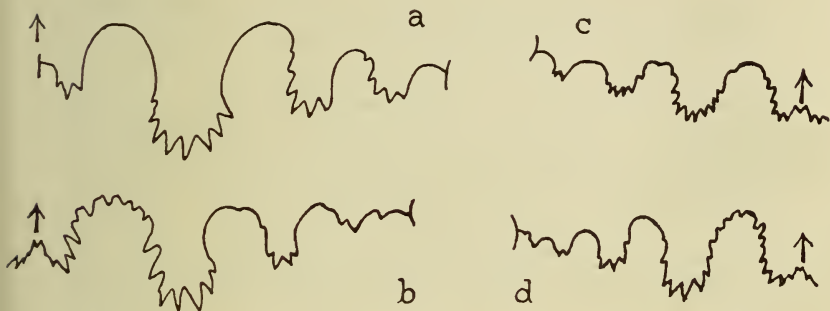


FIG. 147.—Suture-lines of *Paraceratites* (a) and *Frechites* (b-d). a, *Paraceratites trinodosus* (Mojsisovics). b, *Frechites humboldtensis* (Smith). c, *F. pilatus* (Smith). d, *F. occidentalis* (Smith). All enlarged $\times 2$. All from the Middle Trias. American Canyon, Nevada. (After Smith, 1914, pl. lii, fig. 18; pl. lxi, fig. 12, reversed; pl. xlv, fig. 4; and pl. xlv, fig. 23.)

SPECIMENS :

- C. 14053-4.** Dil-Iskelessi, Gulf of Ismid, Asia Minor.
Dr. W. Endriss Coll., 1911.
- C. 5460.** Schreyer Alm, near Hallstatt.
E. v. Mojsisovics Coll., 1889.
- C. 5537.** Schiechlinghöhe, near Hallstatt.
E. v. Mojsisovics Coll., 1889.
- C. 13699.** Same locality.
Purchased, 1910.
- C. 20331, 20481.** Stavljan, Volujak Mts., Bosnia.
V. Hawelka Coll., 1906-08.
- ? **C. 21880, 30928-9** (? 30912-19) (and immature examples)
 Fossil Hill, South Fork of American Canyon, West
 Humboldt Range, Nevada, U.S.A.
Ex J. P. Smith Coll. Presented
Dr. C. T. Trechmann, 1920.

Paraceratites brembanus (Mojsisovics).

1880, p. 710; 1882, p. 38, pl. x, figs. 1a, b (lectotype), 2-4; Gugenberger, 1927, p. 136.

DIAGNOSIS. Like *P. trinodosus*, but with more quadrate whorl-section, more distinctly carinate venter, and more open umbilicus, exposing lateral spines of inner whorls.

MEASUREMENTS :

Mojsisovics, 1882, p. 38, No. I	.	31	·39	·32	·36
" " " " II	.	32	·42	·34	·33

REMARKS. This species is represented in the Collection only by a fragment and some doubtful examples. They are too poorly preserved to show the second (upper) row of lateral spines that characterize the inner whorls of this form ; another is immature, and differs from the similar young of *P. trinodosus* or *P. elegans*, Mojsisovics sp. (1882, p. 31, pl. ix, figs. 5a, b), merely in being slightly more tuberculate, although only three rows of spines are as yet developed.

Yet another (doubtful) fragment is more closely ribbed, like *P. zoldianus* or *P. vindelicus*, Mojsisovics sp. (1882, pl. x, figs. 5-7).

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trinodosus* zone. Alps ; Balkans.

SPECIMENS :

- C. 20333, 20483-4, 20486, 20487.** Stavljan, Volujak Mts., Bosnia.
V. Hawelka Coll., 1906-08.
 ? **C. 30983.** Mali Durmitor Mts., Montenegro (perhaps a new species, with unituberculate inner whorls).
V. Hawelka Coll., 1926.

***Paraceratites subnodosus* (Mojsisovics).**

1882, p. 33, pl. x, figs. 10a, b (lectotype), 9 ; Diener, 1915a, p. 89 ; Kraus, 1916, p. 299.

DIAGNOSIS. Like *P. brembanus*, but without second row of lateral spines on inner whorls, and with no umbilical tubercles on outer whorl.

MEASUREMENTS :

Mojsisovics, 1882, p. 33	.	69	·42	·38 (·40)	·28
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REMARKS. A body-chamber fragment in the Collection bears the label of the Palæontological Institute of the University of Vienna, "*Ceratites evolvens*, Hauer". There is good agreement in ornamentation, but, since the inner whorls are absent, reference of this specimen to Hauer's peculiar species (1888, p. 26, pl. vi, figs. 4a-c) is impossible. Although more compressed than the lectotype of the present species, it may be

included here, and it certainly differs from the example attributed to *P. ellipticus*, Hauer sp. (1888, p. 25, pl. vi, figs. 3a, b). In view of the great variability of these highly ornamented forms, it is considered advisable to include in this species also a Bosnian fragment that has more distant ribs than the holotype. This again leads to what is probably an entirely new form, with resemblance to *Ceratites felsö-örsensis*, Stürzenbaum (Mojsisovics, 1882, p. 36, pl. xiii, figs. 1a-c). As the example (of 95 mm. diameter) is too badly preserved to be figured or described separately, it may also provisionally be included here, although its ribs are twice as coarse and distant as those of *P. subnodosus*, and it might thus even be referable to *Popinites*.

The example from the Schreyer Alm, listed below, is transitional to *P. zoldianus*, Mojsisovics sp. (1882, p. 39, pl. x, fig. 6), with flatter sides and closer costation.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trindosus* zone. Alps, Balkans.

SPECIMENS :

C. 20485. Stavljan, Volujak Mts., Bosnia.

V. Hawelka Coll., 1906-08.

? **C. 30981.** Mali Durmitor Mts., Montenegro.

V. Hawelka Coll., 1926.

C. 23073. Gimaj, Albania.

Baron F. Nopcsa Coll., purchased, 1922.

C. 5423. Schreyer Alm, near Hallstatt.

E. v. Mojsisovics Coll., 1889.

Paraceratites ellipticus (Hauer).

1888, p. 25, pl. vi, figs. 3a, b; Diener, 1915a, p. 81; Kutassy, 1933, p. 473 ("Semiornites").

DIAGNOSIS. Like *P. subnodosus*, Mojsisovics, but larger, more discoidal, and with strong terminal tubercles on all the ribs. Transitional to *Popinites*.

MEASUREMENTS :

Hauer, 1888, pl. vi, fig. 3	.	100 ?	·43	·29	·27
C. 30982	.	100 ?	·44	·27	·23

REMARKS. The only example in the Collection is not only elliptical, like the holotype, but also crushed laterally and corroded, so that the measurements are merely approximate, as in the case of Hauer's original. The smaller, excentric umbilicus points to affinity with Hauer's *Ceratites evolvens*

(1888, p. 26, pl. vi, figs. 4a-c), but the poor state of preservation of the inner whorls precludes definite identification.

The apparently new form referred to above under *P. subnodosus* somewhat resembles the fragment figured by Hauer in 1896 (pl. viii, fig. 3), but in addition to its great whorl-thickness (36% ?) it appears to have *Popinites*-like inner whorls.

HORIZON AND LOCALITIES. Lower Meso-trias, Upper Anisian, *trinodosus* zone. Balkans.

SPECIMENS :

C. 30982. Mali-Durmitor Mts., Montenegro.

V. Hawelka Coll., 1926.

Paraceratites thuilleri (Oppel).

1863, p. 277, pl. lxxvii, fig. 3 (*Ammonites*); Diener, 1915a, p. 90 (*Ceratites*).

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Paraceratites*. Whorl-section compressed, with subparallel sides and slightly arched to subcarinate venter, trituberculate ribs, irregularly bifurcating or with intercalated secondaries, tending to become single, uniform and non-tuberculate in adult. Suture-line as in *P. trinodosus* (see fig. 147a, p. 437).

MEASUREMENTS :

Oppel (1863, p. 277)	.	75	.	43	.	28	.	32
Diener (1895b, p. 21)	.	77	.	43	.	31	.	30
„ (1913, p. 46)	.	47	.	40	.	35	.	21 ?

REMARKS. This species is closely allied to *P. trinodosus*, and differs chiefly in having the row of lateral tubercles inside the line of involution, and thus exposed in the umbilicus. Of two examples in the Collection, determined by Prof. Diener himself, one represents the coarsely and distantly ribbed variety; and since it is still septate at 90 mm. diameter, it must have exceeded in size the (more closely ribbed) body-chamber cast figured by Diener in 1913 (pl. vii, fig. 2). The second specimen has nearly half of the outer whorl belonging to the body-chamber, and shows simplification of the ornamentation, like the much more robust and distantly costate *P. subnodosus*, Mojsisovics sp. (1882, pl. x, fig. 11).

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trinodosus* zone. Himalayas.

SPECIMENS :

C. 28555, 28557. Muth, Spiti.

Coll. *H. H. Hayden. Presented*

Geol. Surv. India, 1926.

C. 28155 ? (Worn fragment.) Stream bed of valley from Dra to Ruli La, Tibet.

Coll. *Mt. Everest Expedition, 1925.*

Paraceratites winterbottomi (Salter).

Plate XVII, figs. 7*a*, *b*.

In Salter and Blanford, 1865, p. 63, pl. vii, fig. 5 (*Ammonites*).

DIAGNOSIS. Like *P. ellipticus*, but more compressed, and with more delicate costation.

MEASUREMENTS :

Holotype	.	? 50	.	? 50	.	? 28	.	? 20
C. 28556	.	63	.	45	.	27	.	24

REMARKS. This species has not hitherto been correctly interpreted, in spite of the fact that Salter's original drawing, although diagrammatic, showed the tri-tuberculate ornamentation. Stoliczka, in 1865 (p. 57), thought that if a keel were really present, as drawn in Salter's figures *b* and *c*, the species might be considered identical with *Amm. thuilleri*, Oppel.

Beyrich, in 1867 (p. 110), held that Salter's species could be regarded as a younger individual of the same form. Yet Mojsisovics, in 1886 (p. 149), simply quoted it as a *Trachyceras*, of presumably "Norian" age, and as recently as 1915 Diener (*a*, p. 35) listed the form as gen. ind. sp. ind. (*Ceratites an Trachyceras* ?), and even queried its Meso-triassic age.

A fragmentary *Ceratites thuilleri* (Oppel), identified by Prof. Diener and presented by the Director of the Geological Survey of India, probably belongs to the present species.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trindodus* zone. Himalayas.

SPECIMENS :

C. 4852. Raj-hoti, Himalayas (Salter's holotype).

Ex Col. *Strachey Coll., transf. Mus. Pract. Geol., 1880.*

C. 28556. Muth, Spiti.

Coll. *Hayden. Presented Geol. Surv. India, 1926.*

Paraceratites ismidicus (Arthaber).

1914. *Ceratites* (*Hollandites*) *ismidicus*, Arthaber, p. 126, pl. xii, figs. 6a-d.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Paraceratites*. Whorl-section compressed, subquadrangular, with broad, gently arched venter and greatest thickness at the lateral tubercle; umbilical wall high and perpendicular, edge rounded. With slightly sigmoidal, bifurcating costæ, with pronounced primary stem only on the inner whorls, and a median tubercle at the line of involution. On the body-chamber the lateral tubercle moves out to the middle of the side and the outer nodes tend to become effaced. Suture-line ceratitic, as in *P. binodosus*.

MEASUREMENTS :

Holotype (Arthaber, pl. xii,

fig. 6)	70	. .	44	. .	35	. .	25
C. 13724	73	. .	42	. .	35	. .	30

REMARKS. The affinities of this species clearly are with *P. binodosus* and *P. thuilleri*, and not with *Hollandites* as Arthaber suggested. Two of the three examples in the Collection were originally referred to *Ceratites elegans*, Mojsisovics, probably because in Toulà's earlier account of the Ismid fauna this species was figured as the only comparable Ceratite. They differ from these figures, however, as much as from Mojsisovics's original *C. elegans* (1882, p. 31, pl. ix, figs. 5, 6), although this has a similar costate umbilicus. In the present form the suggestion of an umbilical tubercle, distinct on the inner whorls, has entirely disappeared on the outer, and the inner half of the lateral area of the body-chamber is only faintly ribbed, as shown in Arthaber's figure. The same author's *Ceratites* (*Semiornites*) *marmarensis*, var. (pl. xii, figs. 5a-c), however, shows a comparable outer whorl, and seems to me similarly referable to the *binodosus* group of *Paraceratites* rather than to *Semiornites*, if we interpret this genus by its genotype, *S. cordevolicus*, Mojsisovics. The American Ceratitids of the *humboldtensis* group show only superficial resemblance to the present species.

HORIZON AND LOCALITIES. Lower Meso-trias, Lower Anisian, *binodosus* zone. Anatolia.

SPECIMENS :

- C. 13724-5.** Dil-Iskelessi, Gulf of Ismid. *Purchased*, 1910.
C. 15042. Same locality. *Dr. W. Endriss Coll.*, 1911.

Paraceratites trojanus, Smith.

1914, p. 88, pl. xxxvi, figs. 1-3 (4, 5), pl. xxxvii, figs. 1-5).

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Paraceratites*. Whorl-section compressed, sides flattened, with indistinct ventral shoulders and narrowly arched venter with blunt keel. Sigmoidal ribs, with, at first small, and later very prominent, lateral spines (about nine to the whorl), and weak outer clavi, tending to disappear towards aperture. No umbilical tubercles.

MEASUREMENTS :

Holotype (Smith, p. 89)	.	65	.	·31	.	·26	.	·26
C. 30891	.	.	.	40	.	·45	.	·35
	.	.	.		.	·35	.	·23

REMARKS. The smaller specimen (C. 30891), of which the measurements are here given, agrees with the inner whorls of the holotype figure, the body-chamber of which is uncoiling, and thus shows a considerably smaller whorl-height. The other figures given by J. P. Smith differ somewhat from specimen C. 30891, and two more examples in the Collection, named by that author, are also different. There are transitions, not only to such forms as *P. cricki*, described below, but also to *P. clarkei* and the form described by J. P. Smith as *P. trinodosus* with umbilical tubercles. A number of immature examples in the Collection cannot be definitely assigned to the present form rather than to any of the allied "species".

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trinodosus* zone. Nevada.

SPECIMENS :

C. 21881, 30890-1. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada, U.S.A.

Ex *J. P. Smith Coll.* Presented
C. T. Trechmann, 1920.

Paraceratites cricki, Smith.

1914, p. 87, pl. xxxvii, figs. 6-9 (10-13; pl. xxxviii, figs. 1-12; pl. xlvii, figs. 19 and 24).

DIAGNOSIS. Like *P. trojanus*, but more strongly keeled, with lateral spine appearing earlier, and outer ends of ribs more pronounced.

MEASUREMENTS :

Holotype	.	.	.	56	.	·43	.	·34	.	·25
C. 30892	.	.	.	60	.	·48	.	·40	.	·25

REMARKS. This species is again very variable and, whilst a number of examples in the Collection agree with the type, there are some flattened varieties comparable to Prof. Smith's figs. 3, 4, 7, 8 (pl. xxxviii). Since these are associated with constricted Arcestids which occur in a matrix slightly different from, and more easily weathered than, that of the remainder of the *Paraceratites*, it is possible that they indicate a distinct horizon, and possibly should be separated specifically from the present species. Some fragments of outer whorls with coarser tuberculation may perhaps be referable to the close ally, *P. taurus*, Smith (1914, p. 88, pl. xxxv, figs. 1-3), described as "the most robust of the keeled Ceratites in Nevada, which has departed furthest from the typical group of *C. cricki*".

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trindodus* zone. Nevada.

SPECIMENS :

C. 30892-5, Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada.

Ex J. P. Smith Coll. Presented
Dr. C. T. Trechmann, 1920.

C. 30896-909, 30920-4, 30910-11 ?, **C. 37347**. Same locality.
Purchased, 1927.

***Paraceratites vogdesi* (Smith).**

1904, p. 384, pl. xliii, figs. 7, 8 (*Ceratites*); pl. xlv, fig. 1; 1914, p. 89, pl. xxxv, figs. 4-9.

DIAGNOSIS. "Like *P. trojanus*, but more evolute, and with more robust whorls, lower venter, stronger and more angular shoulders and stronger sculpture. The lateral knots are about the same in number in both species, but the marginal knots are fewer and coarser on *P. vogdesi*."

MEASUREMENTS :

Holotype (Smith, 1914, p. 90) . 67 43 36 27

REMARKS. The specimen in the Collection, comparable to the holotype, was identified by J. P. Smith, but it has more strongly trituberculate ornamentation almost to the end, and is thus somewhat transitional to forms like Smith's *Ceratites haguei* (1914, p. 97, pl. xlii), which he included in *Popinites* (= "*Kellnerites*").

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trindodus* zone. Nevada, U.S.A.

SPECIMENS :

C. 30985. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada

Ex J. P. Smith Coll. Presented
Dr. C. T. Trechmann, 1920.

Paraceratites clarkei, Smith.

1914, p. 91, pl. xl, figs. 15, 16, 17 (type), 18-23 ; pl. lii, figs. 1-11.

DIAGNOSIS. Like *P. trinodosus*, but with more prominent keel, more compressed whorl-shape, narrower umbilicus, more prominent ventro-lateral shoulders, weaker ribs and stronger tubercles.

MEASUREMENTS :

Holotype (Smith, 1914, p. 91) . 38 .50 .30 .24

REMARKS. J. P. Smith has pointed out that the present species at first greatly resembles the young of *P. cricki*, but that the adult stages of the two species have little resemblance. The example recorded below agrees with Smith's figs. 1-3 of pl. lii, but is slightly larger, and shows the loss, not only of the median and inner tubercles, but also of the keel. All the American species of *Paraceratites* are undoubtedly closely allied, and I do not agree with J. P. Smith's view that larger series of specimens are required, to show an intergradation of many so-called species. J. P. Smith's own figures, the specimens named by himself, and the abundant material from Nevada, lately acquired by the Museum, and as yet largely unsorted, indicate the existence of numerous passage-forms. As in all highly ornamented ammonites, no two specimens are identical, and the recognition of a number of species becomes a matter of systematic convenience.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trinodosus* zone. Nevada, U.S.A.

SPECIMENS :

C. 30984. American Canyon, West Humboldt Range, Nevada, U.S.A. Purchased, 1927.

Genus **FRECHITES**, J. P. Smith.

1932, p. 32.

GENOTYPE. *Ceratites humboldtensis*, Hyatt and Smith, 1905, p. 170, pl. lvii, figs. 1-23.

DIAGNOSIS. *Gymnotoceras*-like Ceratitidæ, with a tendency to

tuberculation at the ventro-lateral edges and at the point of bifurcation of the ribs. Keel faint or absent. Suture-line ceratitic.

DISTRIBUTION. Lower Meso-trias, Anisian. Nevada.

REMARKS. Certain species left in *Gymnotoceras* are undoubtedly transitional to the genus here described, for example *G. hersheyi*, Smith (1914, p. 110, pl. xciii, figs. 1-3), which has the outer tubercle of *Frechites*, but a strong keel; or *G. wemplei*,

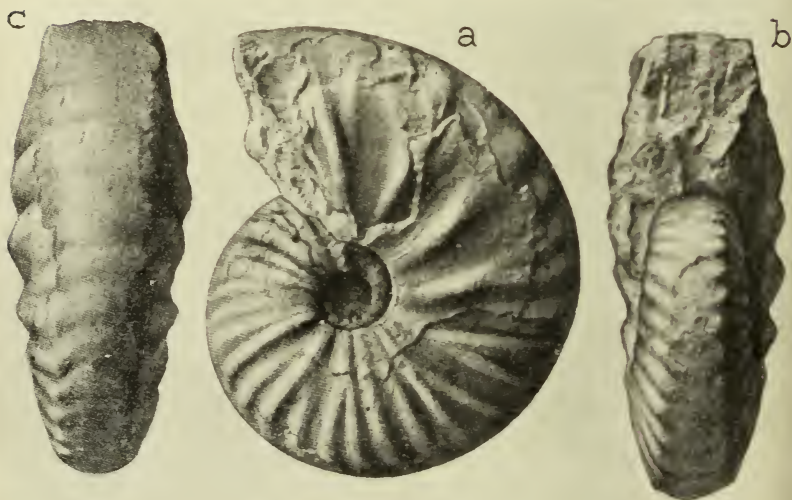


FIG. 148.—*Frechites pilatus* (Smith). Side- and two peripheral views of holotype. Middle Trias. American Canyon, Nevada. (After Smith, 1914, pl. lxxxix, figs. 10-12.)

Smith (1914, p. 113, pl. lxxviii, figs. 1-9), with the lateral tubercle tending to become almost as prominent as in the *humboldtensis* group. On the other hand, *F. spinifer*, Smith, described below, converges towards *Paraceratites*, so that it appears probable that all these genera have a common origin in a *Gymnotoceras*-like ancestral group. The type-specimens of Smith's "*Philippites*" *lawsoni* (1914, p. 108, pl. lvi, figs. 1-4) and "*Hollandites*" *organi* (1914, p. 105, pl. liv, figs. 1-4) are thus also more appropriately included in *Frechites*, in spite of their evident affinity with certain *Gymnotoceras*; for, as already

mentioned, the Himalayan true *Hollandites* and the Alpine *Philippites* are entirely distinct from the Nevada forms.

Again, Smith's divisions of his "*Ceratites nodosi*" are not adopted. He correctly included *Ceratites pilatus*, belonging to the present genus, in his group VI (of *C. humboldtensis*), but placed its close allies, *C. occidentalis*, etc., in a different group (II); he compared this last species to the European *Semiornites planus*, Arthaber sp. (1896, p. 45, pl. iv, figs. 2a-c), which on its inner whorls has the tri-tuberculate ornamentation of *Paraceratites*, and is almost certainly only distantly related to the group here discussed.

Similarly Smith's group I (of *Ceratites rotuloides*), said to be the most primitive, and certainly connected with the typically less rectiradiate *Gymnotoceras*, like *G.* [*"Hollandites"*] *montis-bovis*, was wrongly compared to the Alpine *Semiornites prettoii* (Tornquist). It is here taken to represent merely an extreme *Frechites*, the spinate forms of the *nevadanus* type being opposite extremes.

Arthaber (1914, p. 120) considered *F. humboldtensis* to be merely the Pacific form of *Paraceratites trinodosus*, and called *Gymnotoceras* only a vicarious type of the Mediterranean *trinodosi*. It must be admitted that *F. humboldtensis* and allies converge towards *Paraceratites*, but there are a number of typical forms of the last genus in the Nevadan Trias, resembling much more closely the Mediterranean forms than do the *Frechites* here discussed.

***Frechites humboldtensis* (Hyatt and Smith).**

1905, p. 170, pl. lvii, figs. 1-3 (4-23); 1914, pl. vii, figs. 1-23; pl. lxi, figs. 1-15; Arthaber, 1914, p. 120, text-figs. 7e, f.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Frechites*. Whorl-section trapezoidal, with the greatest width at the lower third, marked by prominent lateral tubercles. Venter broad, with low median ridge and abrupt edges, bordered by sub-tuberculate ends of lateral (single or bifurcating) ribs. Suture-line subceratitic as in *F. pilatus* (see fig. 147b, p. 437).

MEASUREMENTS :

Lectotype (Hyatt and Smith,

pl. lvii, figs. 1-3)	.	.	.	45	44	42 ?	24
Paratype (<i>ib.</i> , figs. 6, 7)	.	.	.	60	42	42	26

REMARKS. J. P. Smith considered this species to be the American representative of the Alpine *Paraceratites subnodosus*; but the latter has not only entirely different inner whorls (resembling those of *Paraceratites brembanus*, Mojsisovics sp., 1882, pl. x, fig. 1), but much less coarse and much closer lateral tuberculation in the adult. *F. emmonsii*, Smith (1914, p. 98, pl. lx, figs. 13-15 [16-21]), said to be more compressed laterally and more evolute than the species here described, and to have square shoulders and stronger spines, is connected with it by numerous transitions, as is also *F. spinifer*.

HORIZON AND LOCALITIES. Mseo-trias, Anisian, *trinodosus* zone. Nevada, U.S.A.

SPECIMENS:

C. 31039-42. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada.

Ex J. P. Smith Coll. Presented

Dr. C. T. Trechmann, 1920.

C. 31062-95, 31173-87. Same locality. Purchased, 1927.

***Frechites spinifer* (J. P. Smith).**

1914, p. 103, pl. lix, figs. 1-3 (4-10, pl. lx, figs. 1-12).

DIAGNOSIS. *Frechites* intermediate between *F. humboldtensis* and *F. cornutus*. It differs from the former in its wider umbilicus, square ventral shoulders, more flattened venter, weaker keel, stronger spines and marginal tubercles; from the latter in its wider umbilicus, more compressed whorls and narrower venter.

MEASUREMENTS:

Holotype 60 . 43 . 37 . 33

REMARKS. J. P. Smith was probably right in thinking that the resemblance of this form to the typical *Ceratites nodosus* is due to convergence, for, as he remarked, the adolescent stage in *Frechites* resembles *Gymnotoceras*. The writer, however, does not agree with him in his phylogenetic speculations. *Frechites* is merely an earlier development of the same stock that later produced the true *Ceratites*; the resemblance, in the adult, of the early forms of the Lower Ceratite Beds to *Frechites* is of greater significance for tracing affinity than the differences in the inner whorls.

HORIZON AND LOCALITIES. Meso-trias, Anisian, *trinodosus* zone. Nevada, U.S.A.

SPECIMENS :

C. 21878-9. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada.

Ex *J. P. Smith Coll.* Presented

Dr. C. T. Trechmann, 1920.

C. 31056-61. Same locality.

Purchased, 1927.

Frechites cornutus (*J. P. Smith*).

1914, p. 98, pl. lxii, figs. 1-3 (4-17).

DIAGNOSIS. Like *F. humboldtensis*, but with broader whorls, flatter venter, weaker keel and much stronger lateral spines and ventro-lateral tubercles. Suture-line as in *F. humboldtensis*.

MEASUREMENTS :

Holotype 60 . 47 . 40 . 27

REMARKS. This species closely resembles the last two, and is connected with them by many transitions. In *F. spinifer* the venter is typically less broad, the whorls less inflated, and the umbilicus wider. *F. humboldtensis* differs chiefly in having less strongly developed tuberculation. They are all three somewhat intermediate between the typical early Paraceratitids and Gymnotoceratids and certain simplified, true Ceratites of the Muschelkalk.

HORIZON AND LOCALITIES. Meso-trias, Anisian, *trinodosus* zone. Nevada, U.S.A.

SPECIMENS :

C. 31043-4. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada.

Ex *J. P. Smith Coll.* Presented

Dr. C. T. Trechmann, 1920.

C. 31045-55. Same locality.

Purchased, 1927.

Frechites emmonsii (*Smith*).

1914, p. 98, pl. lx, figs. 13-15 (16-21).

DIAGNOSIS. Like *F. spinifer*, but more compressed, with flatter sides and narrower venter; also less tuberculate.

MEASUREMENTS :

Holotype 44 . 46 . 40 . 25

REMARKS. This form is also close to *F. humboldtensis*, which has less flattened whorl-sides and less distinctly marked tubercles

at the ventro-lateral shoulders. *F. cornutus* similarly is more inflated, whilst *F. nevadanus* also has a much wider venter.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trindodus* zone. Nevada, U.S.A.

SPECIMENS :

C. 31149. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada.

Ex J. P. Smith Coll. Presented

Dr. C. T. Trechmann, 1920.

C. 31170-2. Same locality.

Purchased, 1927.

***Frechites nevadanus* (Mojsisovics).**

1888, p. 168 ; Smith, 1914, p. 101, pl. xv, figs. 6, 6a ; pl. lxiv, figs. 1-14 ; pl. lxv, figs. 1-13.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Frechites*. Whorl-section subquadrate ; venter broad and flat, with coarse, bifurcating ribs with prominent lateral tubercles and faint ventro-lateral nodes. The young are like *Gymnotoceras*, but without a keel. Suture-line ceratitic, with rounded and entire saddles.

MEASUREMENTS :

Smith, pl. lxiv, figs. 1, 2 . 74 . 46 . 46 . 23

REMARKS. This species had been included by Meek in *Gymnotoceras blakei*, and there are, indeed, numerous transitions to species of *Gymnotoceras* with the keel more-or-less poorly developed. Prof. Smith's view that there is not the slightest resemblance between the two species at any stage of growth is not supported by his own figures or a study of actual specimens. The restricted *Gymnotoceras blakei*, of course, is less close than forms like *G. wemplei*, Smith, discussed above ; it may also be remembered that the appearance of a keel at different stages in different forms of the Beyrichitids and Ceratitids is not here considered to be of phylogenetic significance.

F. humboldtensis has a less broad and flat venter and a distinct keel. *F. karpinskyi* has more delicate ornamentation and clavate outer endings of the lateral ribs. There are many unsorted immature *Frechites* of the *humboldtensis* group, in addition to the registered specimens here listed, and it is probable that they include numerous young of the present species.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trindodus* zone. Nevada, U.S.A.

SPECIMENS :

- C. 31143-8. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada. Ex *J. P. Smith Coll.*
Presented Dr. C. T. Trechmann, 1920.
- C. 31188-94. Same locality. Purchased, 1927.

Frechites karpinskyi (Smith).

1914, p. 100, pl. xliv, figs. 4-6 (7-20).

DIAGNOSIS. Like *F. nevadanus*, but with a more rectangular whorl-section, flattened ribs with clavate peripheral terminations, and loss of lateral tubercles in adult.

MEASUREMENTS :

Holotype . . . 42 . 48 . 36 . 27

REMARKS. This species also closely resembles *F. occidentalis*, described below, which, however, has a more compressed whorl-shape, narrower venter, and less tuberculate ornamentation. In the flattening of its ribs *F. karpinskyi* shows some resemblance to typical *Paraceratites*, e. g. *P. trinodosus*, but there is no umbilical tubercle, and in the earlier stages the present form is similar to young *Gymnotoceras*. Prof. J. P. Smith was undoubtedly right in including *F. karpinskyi* in the "*humboldtensis* group", but the convergence towards the true *Ceratites* (*i. e.* the *nodosi*) is easily explained, since they are developments of the same radical stock.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trinodosus* zone. Nevada, U.S.A.

SPECIMENS :

- C. 31259. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada. Purchased, 1927.
- Probably also a number of the immature *Frechites* referred to above.

Frechites pilatus (Smith).

Fig. 148, p. 446.

1914, p. 102, pl. lxxxix, figs. 10-13 (pl. xlvi, figs. 1-16).

DIAGNOSIS. Like *F. humboldtensis*, but more compressed and less strongly ornamented. Suture-line, see fig. 147c, p. 437.

MEASUREMENTS :

Holotype . . . 55 . 42 . 31 . 24

REMARKS. This species is rather variable and, in the wider interpretation here adopted, it includes a number of transitions between the *humboldtensis* and *occidentalis* groups, whilst one extreme example (C. 31300) might even be considered a passage-form to *Gymnotoceras hersheyi*, Smith (1914, p. 110, pl. xciii, figs. 1-3). *F. occidentalis* is closely similar to *F. pilatus*, and only slightly more compressed and less coarsely ribbed, but there are too many passage forms to separate the two species into different groups. *F. karpinskyi* is also allied to *F. pilatus*, but has a more rectangular whorl-section and more prominent ventro-lateral clavi.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trinodosus* zone. Nevada, U.S.A.

SPECIMENS :

C. 30986-9. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada.

Presented Dr. C. T. Trechmann, 1920.

C. 31260-91, 31300. Same locality. *Purchased, 1927.*

C. 32435. Same locality. *Exchange, Dr. H. G. Schenk, 1929.*

***Frechites occidentalis* (Smith).**

1914, p. 84, pl. xlv, figs. 21-23 (24-28, pl. xlv, figs. 1-13).

DIAGNOSIS. Like *F. pilatus*, but more compressed and with slightly less robust ornamentation. Suture-line, see fig. 147d, p. 437.

MEASUREMENTS :

Holotype 52 . 48 . 38 . 21

C. 21882 (metatype) . . . 54 . 48 . 34 ? . 17

REMARKS. This form is as variable as *F. pilatus*, and an inspection of the two figures given by Prof. J. P. Smith in his pl. xlv (figs. 21 and 24) shows that he interpreted it widely himself. There are passage-forms to a number of other species of *Frechites*, and to *Gymnotoceras*. The form described below as *F. rotuloides* is less robust and more finely ornamented, as also is *F. altilis*, which, moreover, has its ribs much more closely set. The resemblance of *F. occidentalis* to the Mediterranean *Semiornites planus*, Arthaber sp. (1896, p. 45, pl. iv, figs. 2a-c), with trinodose inner whorls, in the writer's opinion, is quite superficial.

Among the large number of unsorted immature *Frechites*

in the Collection (and already referred to under *F. humboldtensis*), there are probably also young of the species here discussed.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trindodus* zone. Nevada, U.S.A.

SPECIMENS :

C. 21882, 31140-2. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada.

Presented Dr. C. T. Trechmann, 1920.

C. 31195-258. Same locality. *Purchased, 1927.*

C. 32436. Same locality. *Exchange, Dr. H. G. Schenk, 1929.*

***Frechites altilis* (Smith).**

1914, p. 83, pl. lxvii, figs. 19-21 (pl. xlv, figs. 14-22).

DIAGNOSIS. Like *F. occidentalis*, but more compressed and with more numerous and finer ribs.

MEASUREMENTS :

Holotype . . . 50 . 52 . 34 . 20

REMARKS. There are again transitions between this species and the slightly more robust *F. occidentalis*; also passage-forms to the ventrally more rounded *F. rotuloides* and to the more evolute *F. tenuispiralis*, described below. There is probably far less affinity with Hauer's *Ceratites falcifer*, here referred to the genus *Semiornites*. The Alpine form shows only superficial resemblance to *F. altilis* in the adult; the inner whorls are quite different, and even the ribbing, with branching taking place at an umbilical tubercle, is entirely unlike the *Gymnotoceras*-like costation of the earlier whorls of *Frechites*.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trindodus* zone. Nevada, U.S.A.

SPECIMENS :

C. 27333. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada. *In exchange, 1926.*

C. 31295-6. Same locality. *Purchased, 1927.*

***Frechites tenuispiralis* (Smith).**

1914, p. 81, pl. xlvi, figs. 17-19 (20-25).

DIAGNOSIS. Like *P. altilis*, but more evolute and consequently with lower whorl-height.

MEASUREMENTS :

Holotype . . . 34 . .41 . .34 . .30

REMARKS. This is probably not an independent species, and is based on immature examples that differ from the last species only in their wider umbilicus. *F. rotuloides*, described below, has slightly finer costation and a smaller umbilicus.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trindodus* zone. Nevada, U.S.A.

SPECIMENS :

C. 31297-9. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada. *Purchased, 1927.*

***Frechites rotuloides* (Smith).**

1914, p. 80, pl. xlvii, figs. 1-3 (4-10).

DIAGNOSIS. Like *F. altilis*, but with still more delicate costation and more rounded ventral area.

MEASUREMENTS :

Holotype . . . 67 . .42 . .25 . .19

REMARKS. Prof. Smith considered the present species and some similarly non-tuberculate allied forms to represent the most primitive *Ceratites*, and to come nearest to the ancestral Meekoceratidæ. In the writer's opinion, however, the forms of the *rotuloides* and *occidentalis* groups of Smith, with some less highly ornamented forms of his *humboldtensis* group, are all merely variations of one local stock, and intimately allied with the *Beyrichites* and *Gymnotoceras* of the beds immediately below. The comparisons of such forms as *Frechites rotuloides* with the European *Ceratites prettoi*, Tornquist (1898, p. 645, pl. xx, fig. 3), and of *Frechites* of the *occidentalis* group with the Alpine *Semiornites falcifer* (Hauer) and *S. planus* (Arthaber), are based merely on a slight similarity of the outer whorls. One of the examples in the Collection (C. 31294), larger than the holotype of *F. rotuloides*, shows pronounced weakening of the costation at the end; but the immature specimens have the usual *Gymnotoceras* aspect. There is a large number of these, but they are too small to be sorted. They may, of course, include the young of other "species" of J. P. Smith's *rotuloides* group.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trindodus* zone. Nevada, U.S.A.

SPECIMENS :

- C. 31292-4. Fossil Hill, South Fork of American Canyon, West Humboldt Range, Nevada. *Purchased, 1927.*

Genus SEMIORNITES, Arthaber.

1912, p. 342 ; 1914, p. 121 (as sub-genus of *Ceratites*).

GENOTYPE. *Ceratites cordevolicus*, Mojsisovics, 1882, p. 26, pl. xii, figs. 5a, b (lectotype), 6, 7.

DIAGNOSIS. Semiornate Ceratitids, with either no distinct ribbing at all (*S. cordevolicus*, Mojsisovics), or with the tuberculation reduced to a single row (*S. semiornatus*, Arthaber), or with the bifurcation of ribs occurring already at the umbilical edge (*S. falcifer*, Hauer). Suture-line ceratitic (fig. 150a, b, p. 456).

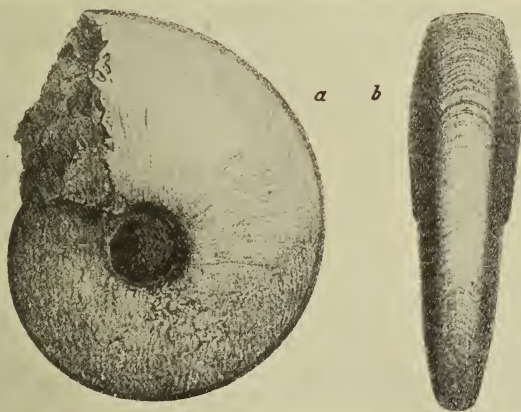


FIG. 149. — *Semiornites cordevolicus* (Mojsisovics). Side- and peripheral views of lectotype. Middle Trias, *trinodosus* zone. Buchenstein, South Tyrol. (After Mojsisovics, 1882, pl. xxii, figs. 5a, b.)

DISTRIBUTION. Lower Meso-trias, Upper Anisian, *trinodosus* zone. Alps ; Balkans ; Himalayas.

REMARKS. Diener (1915a, p. 100) listed only Arthaber's *Ceratites paluzzanus* (1912, p. 351, pl. xvii, figs. 3-6) in addition to the genotype, but other species of *Semiornites* were indicated by Arthaber in 1914 (see diagnosis above). There are, of course, many passage-forms to the true *Paraceratites*, but as

already mentioned on p. 442, the robust outer whorl of Arthaber's *Ceratites* (*Semiornites*) *marmarensis* var. does not indicate affinity either with the *cordevolicus* group or *S. paluzzanus*. On the other hand, *S. lenis*, although more strongly keeled than *S. semiornatus* or *S. glaber*, Arthaber sp. (1896, pl. iii, figs. 7, 8), may be more appropriately included here than forms with a median, lateral tubercle.

Some Nevada forms of J. P. Smith's group of *Ceratites rotuloides* show superficial resemblance to *Semiornites*, but are here believed to be merely homœomorphous developments of *Frechites*.

***Semiornites falcifer* (Hauer).**

1896, p. 258, pl. viii, figs. 5, 6 ; Kutassy, 1933, p. 473.

DIAGNOSIS. Platygyral, subleptogyral, subangustumbilicate *Semiornites*. Whorl-section compressed, rectangular, with almost parallel sides and tabulate venter, slightly raised along the siphonal line. With falcoid ribs, single or bifurcating at the faint umbilical nodes ; ventro-lateral terminations clavate. Suture-line ceratitic, with entire but narrow-stemmed saddles.

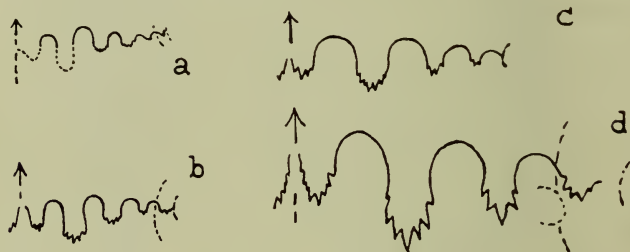


FIG. 150.—Suture-lines of *Semiornites*, *Popinites*, *Bulogites*. a, *Semiornites cordevolicus* (Mojsisovics). After Mojsisovics (1882, pl. xii, fig. 6). b, *S. semiornatus* (Arthaber). After Arthaber (1896, pl. iii, fig. 7d, reversed). c, *Popinites bosnensis* (Hauer). After Hauer (1888, pl. vi, fig. 1c). d, *Bulogites multinodosus* (Hauer). After Hauer (1892, pl. iii, fig. 1c). All from the Middle Trias, *trinodosus* zone.

MEASUREMENTS :

Holotype (Hauer, p. 259)	65 (48)	·50	·30	·21
C. 5424 (transition to <i>S. aviticus</i>)	71	·51	·27	·17

REMARKS. This species differs from *Semiornites aviticus*, Mojsisovics sp. (1882, p. 24, pl. xii, figs. 2-4), merely in its stronger ornamentation. The Schreyer Alm fragment listed below is

somewhat transitional between the two species. *S. cordevolicus*, the genotype of *Semiornites*, is still less distinctly ribbed. The example from Bosnia, recorded below, is immature, and cannot, perhaps, be definitely identified, but like the small specimens referred to *S. lenis*, it belongs to the genus *Semiornites*, not previously recorded from Stavljan (see Gugenberger, 1927, p. 136).

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trindosus* zone. Alps; Balkans.

SPECIMENS:

C. 20329. Stavljan, Volujak Mts., Bosnia.

V. Hawelka Coll., 1908.

C. 5424. Schreyer Alm, near Hallstatt.

E. v. Mojsisovics Coll., 1889.

Semiornites lenis (Hauer).

1896, p. 252, pl. vi, figs. 1, 2 (lectotype), 3-8; Kutassy, 1933, p. 474.

DIAGNOSIS. Like *S. falcifer*, but less distinctly ribbed, and with a pronounced keel.

MEASUREMENTS:

Lectotype	110	·46	·25	·17
Hauer, p. 252 (mean of three examples)	—	·50	·30	·16

REMARKS. The two immature examples in the Collection are perhaps as close to *S. falcifer*, described above, as to the present species; but they differ from the young form referred to the former in being more involute and more compressed. The faint, falcoid ribbing is probably similar in the immature examples of both species, but the young of *S. falcifer* is almost smooth, the development in the two species being more-or-less reversed, *i. e.* from ribbed to smooth in *S. lenis*, and from smooth to ribbed in *S. falcifer*.

Paraceratites evolvens, Hauer sp. (1888, p. 26, pl. vi, figs. 4a-c), which was rightly considered by the same author to be closely allied to *S. lenis*, may be impossible to distinguish at small diameters.

HORIZON AND LOCALITIES. Lower Meso-trias, Anisian, *trindosus* zone. Alps; Balkans.

SPECIMENS:

C. 20330, 20332. Stavljan, Volujak Mts., Bosnia.

V. Hawelka Coll., 1908.

Genus **POPINITES**, Salopek.

1915, p. 10 [= *Bosnites*, Frech, *non* Hauer, = *Kellnerites*, Arthaber ; 1912, p. 342 ; 1914, p. 121 ; J. P. Smith, 1914, p. 78 ; Diener, 1915a, p. 98 (as sub-genus of *Ceratites*)].

GENOTYPE. *Ceratites bosnensis*, Hauer, 1888, p. 24, pl. vi, figs. 1a-c (*non* 2 ?).

DIAGNOSIS. Ceratitids with the maximum of sculpture, chiefly in the form of several rows of tubercles, with the outer most prominent. Periphery subcarinate ; suture-line ceratitic.

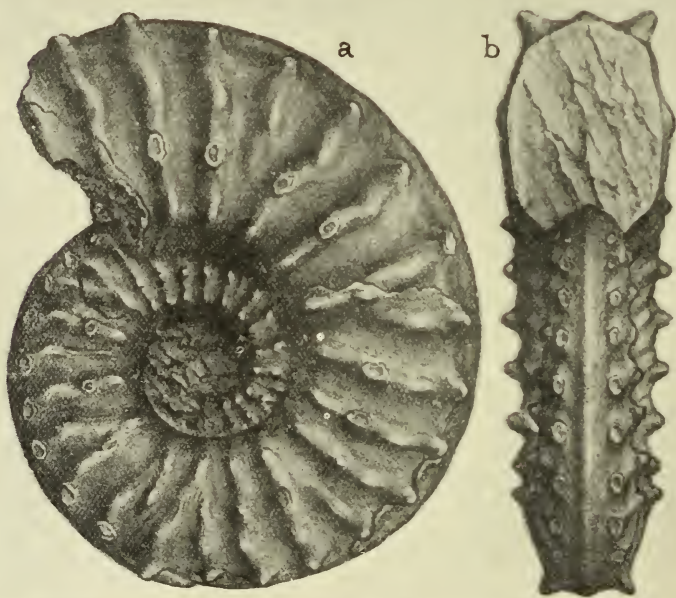


FIG. 151.—*Popinites bosnensis* (Hauer). Side- and peripheral views of lectotype. Middle Trias, *trinodosus* zone. Bosnia. (After Hauer, 1888, pl. vi, figs. 1a, b.)

DISTRIBUTION. Meso-trias, Anisian, *trinodosus* zone. Alps ; Balkans ; Greece ; Nevada.

REMARKS. It is probable that, as Prof. J. P. Smith thinks, *Popinites* (" *Kellnerites* ") is the direct forerunner of *Nevadites*, and thus the ancestor of the Trachyceratids. On the other hand, it is closely connected with such forms of *Paraceratites*

as *P. ellipticus* or *P. subnodosus*, in which the outer tubercle is exaggerated, and, as mentioned above (p. 439), it may be a matter of opinion whether the passage-forms are included in *Paraceratites* or in *Popinites*.

Popinites bosnensis (Hauer).

Fig. 151.

1888, p. 24, pl. vi, figs. 1a-c (lectotype), figs. 2a-c; Kraus, 1916, p. 300; Kutassy, 1933, p. 472.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Popinites*. Whorl-section sub-hexagonal with compressed sides; venter sub-carinate; with strong, radial ribs, with at first three, and later four, prominent tubercles; also occasional intercalated secondaries bearing only the two outer nodes. Suture-line (fig. 150c) ceratitic, with low, rounded, entire saddles.

MEASUREMENTS :

Lectotype (Hauer, p. 25)	. 77	. 41	. 34	. 33
Paratype (Hauer, p. 25)	. 50	. 38	. 41	. 24
Kraus (1916, p. 300)	. 71	. 35	. 32	. 37

REMARKS. The Collection includes a complete example of 36 mm. diameter, entirely septate, and a typical larger fragment, partly body-chamber. Among the American forms of *Popinites* described by J. P. Smith, there is none closely comparable to the present well-known species.

HORIZON AND LOCALITIES. Meso-trias, Anisian, *trinodosus* zone. Alps; Balkans.

SPECIMENS :

C. 20328, 20482, 21719 (?). Stavljan, Volujak Mts., Bosnia.

V. Hawelka Coll., 1908.

Genus **BULOGITES**, Arthaber.

1912, p. 342; 1914, p. 121; J. P. Smith, 1914, p. 78; Diener, 1915a, p. 92.

GENOTYPE. *Ceratites multinodosus*, Hauer, 1892, p. 260, pl. iii, figs. 1a-c.

DIAGNOSIS. Ceratitids with rectangular whorl-section, broad flattened venter and close costation. Three or four rows of tubercles, more-or-less equal-sized. Suture-line ceratitic (see fig. 150d, p. 456).

DISTRIBUTION. Meso-trias, Anisian, *trinodosus* zone. Alps; Balkans.

REMARKS. Prof. J. P. Smith (1914, p. 78) thought that *Bulogites* and "*Kellnerites*" were synonymous, and that Arthaber's subsequent definition of the former as intermediate between the *trinodosus* group and "*Kellnerites*" did not sufficiently emphasize the special characteristics of the present genus. In the Collection there are examples apparently referable to *B. superbus* (Mojsisovics), *B. sondershusanus* (Picard), and *B.*

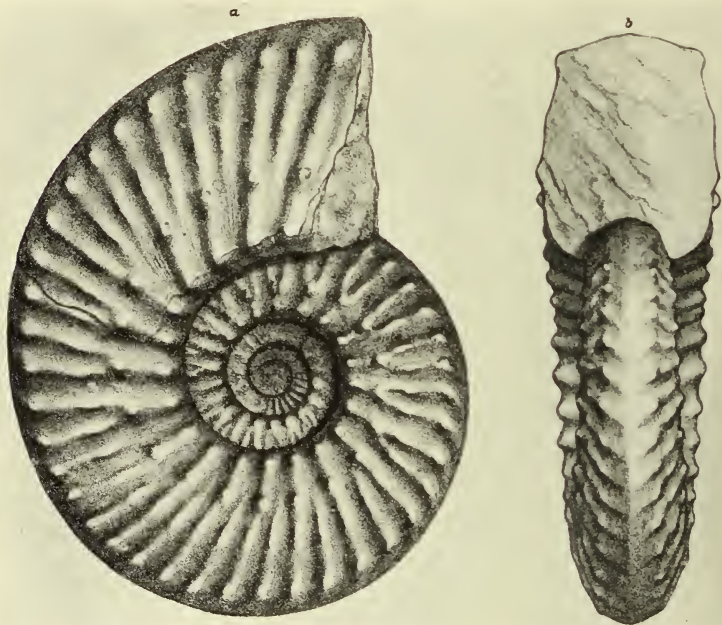


FIG. 152.—*Bulogites multinodosus* (Hauer). Side- and peripheral views of holotype. Middle Trias, *trinodosus* zone. Bosnia. (After Hauer, 1892, pl. iii, figs. 1a, b.)

multinodosus (Hauer), showing various types of ribbing, and especially the smooth periphery found in Hauer's *Ceratites celtitiformis*. This last has now also been recorded from Bosnia (Gugenberger, 1927, p. 136), and its suture-line is similar to that of *B. multinodosus*. There appears to be no doubt that *Ceratites celtitiformis* and *Reiflingites* are closely allied to *Bulogites*, which can thus be defined as morphologically intermediate between *Paraceratites* and *Reiflingites*. The genus *Popinites* (= "*Kellnerites*"), with prominent outer tubercles and a sub-carinate periphery, is therefore clearly independent.

Bulogites multinodosus (Hauer).

Fig. 152.

1892, p. 260, pl. iii, figs. 1a-c; 1933, Kutassy, p. 463.

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Bulogites*. Whorl-section rectangular, sides almost parallel, venter sub-tabulate. With close, prorsiradiate ribs, bifurcating, or with intercalated secondaries and four small tubercles—the innermost at the perpendicular umbilical edge, the inner-lateral about one-third up the whorl-side, and the outer at ventro-lateral edge. The less distinctly marked outer-lateral tubercle is half-way between the outer and inner-lateral. About 20 inner and 35–40 outer tubercles. Suture-line ceratitic (see fig. 150d, p. 456).

MEASUREMENTS :

Holotype (Hauer, 1892, p. 261) 110 . 39 . 32 . 31

REMARKS. Three of the examples listed below are more coarsely ornamented than the typical form, and might thus be referred to *B. sondershusanus*, Picard sp. (see Arthaber, 1896, p. 52, pl. v, figs. 1a–d). It may, however, be doubted whether the anomalous coarseness of the ribbing of at least the inner whorls of the Schaumkalk species is not due to erroneous restoration, and since in such highly ornamented ammonites no two individuals are exactly alike, it is considered preferable to assign all the Bosnian and Montenegrin examples in the Collection to Hauer's species. The largest, with probably the whole of its body-chamber, has dimensions 92–40–32–33, and on account of its delicate ornamentation it might perhaps be compared to *B. superbus*, Mojsisovics sp. (1882, p. 32, pl. xxxiii, fig. 5). This, however, is slightly more compressed, and has a smaller umbilicus, its proportions being 82–41–27–28. *B. reiflingensis*, Arthaber sp. (1896, p. 56, pl. v, figs. 3a–c), with a still smaller umbilicus, is another allied species.

HORIZON AND LOCALITIES. Meso-trias, Anisian, *trinodosus* zone. Alps; Balkans.

SPECIMENS :

C. 20327. Stavljan, Volujak Mts., Bosnia.

V. Hawelka Coll., 1908.

C. 30977–80. Mali-Durmitor Mts., Montenegro.

V. Hawelka Coll., 1926.

Genus **REIFLINGITES**, Arthaber.

1896, p. 72 ; Diener, 1915a, p. 247.

GENOTYPE. *R. eugeniae*, Arthaber, 1896, p. 75, pl. vii, fig. 3.

DIAGNOSIS. Evolute Ceratitids, with trapezoidal whorl-section, tabulate or feebly carinate, broad venter and strong, lateral, projected ribbing, with one to three inner and generally also faint ventro-lateral, tubercles. Suture-line ceratitic, with small second-lateral lobe.

DISTRIBUTION. Anisian. . Alps.

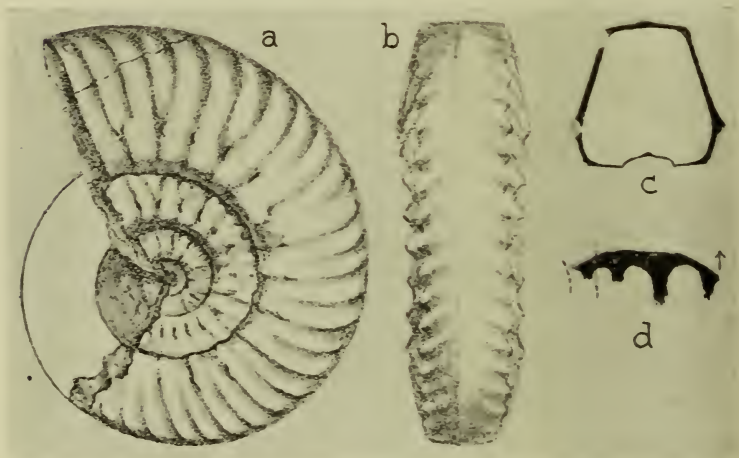


FIG. 153.—*Reiflingites eugeniae*, Arthaber. Anisian, Reifling Limestone. (After Arthaber, 1896, pl. vii, figs. 3a-d.)

REMARKS. This genus has not been accepted by authors other than Hyatt, and is still included by Kutassy (1933) in the synonymy of the closely-allied genus *Danubites*. In its most typical forms, *Reiflingites* is, perhaps, distinct enough from the non-tuberculate *Danubites* (= "*Florianites*"), on the one hand, and the more ceratitoid, discoidal *Bulogites* on the other, to be retained as a separate genus, although it does not seem to have been found outside the Reifling area (Styria), except possibly in Bosnia (*R. ? crassus*, Hauer sp., 1896, p. 259, pl. viii, figs. 1, 2). The other Bosnian "*Reiflingites*" recorded by Kraus (1916, pp. 304-6) were referred by Gugenberger (1927, p. 138) to *Danubites* and *Celtites*; they cannot be considered to be typical *Reiflingites*.

There are a number of such Bosnian examples in the Collection, mentioned below (Part II) under *Danubites* (= "*Florinites*"), that might, perhaps, also be included in *Reiflingites*; but they are so intimately allied to the forms of the group of *D. floriani* (Mojšisovics) that generic separation seems impossible.



FIG. 154.—*Salterites oberhummeri*, Diener. Side- and peripheral views and suture-line of holotype. Middle Trias. Himalayas. (After Diener, 1907, pl. v, figs. 1a-c.)

Genus **SALTERITES**, Diener.

1907, p. 70 (as sub-genus of *Ceratites*).

GENOTYPE. *Salterites oberhummeri*, Diener, 1907, p. 70, pl. v, fig. 1 ; 1915a, p. 100.

DIAGNOSIS. Rather evolute, discoidal Ceratitidæ, with arched

venter and general resemblance to *Hollandites*, but with strong umbilical tubercles which, in later stages, move outwards, still serving as points of bifurcation of the broad ribs. These are at first straight, but later slightly falciform, and terminate at the ventro-lateral edges in small tubercles. Suture-line ceratitic, as in *Hollandites* or *Keyserlingites*.



FIG. 155.—*Haydenites hatscheki*, Diener. Side- and peripheral views (reduced to $\frac{3}{8}$ linear) of holotype. Middle Trias. Himalayas. (After Diener, 1907, pl. vi, figs. 1a, b.)

DISTRIBUTION. Meso-trias, Anisian. Himalayas.

REMARKS. The genus is represented by the single example, here refigured in fig. 154, but it is not easy to interpret correctly from Diener's description and from the illustration of the indifferently preserved holotype. *Salterites* appears to be closer to some *Frechites* than to *Keyserlingites*, with which Prof. Smith (1914, p. 75) had allied it.

Genus **HAYDENITES**, Diener.

1905*b*, p. 790 ; 1907, p. 72 (as sub-genus of *Ceratites*) ; J. P. Smith, 1914, pp. 75 and 114 ; Diener, 1915*a*, p. 96 ; Welter, 1924, p. 592.

GENOTYPE. *Haydenites hatscheki*, Diener, 1907, p. 72, pl. vi, fig. 1 ("hatschekii").

DIAGNOSIS. "Widely umbilicated *Ceratites*, with outlines strongly recalling the Cretaceous genus *Acanthoceras*, and with the ornamentation of *Hollandites* in the inner whorls, of *Keyserlingites* in the chambered portion of the last volution, and of *Ceratites truncus*, Oppel sp. [= *Salterites* ?], in the body chamber."

DISTRIBUTION. Meso-trias, Anisian. Balkans ; Himalayas ; Nevada.

REMARKS. Diener was apparently greatly puzzled by the numerous cases of convergence shown by the Himalayan Ceratitids, and his description of *Haydenites*, above cited, is not more helpful than Prof. J. P. Smith's (1914, p. 75) characterization of this genus as apparently intermediate between *Keyserlingites*, Hyatt, and *Acrochordiceras*, Hyatt. A re-examination of the types would probably reveal that the genera *Haydenites* and *Salterites* may cover a number of those Himalayan "nodosi" that (partly, no doubt, on account of their fragmentary preservation) cannot be satisfactorily referred to any other known genera.

INCERTÆ SEDIS.

? Genus **PERIPLEUROCYCLUS**, Diener.

1907, p. 69 ; 1915*a*, p. 99 (as sub-genus of *Ceratites*).

GENOTYPE. *Peripleurocyclus smithianus*, Diener, 1907, p. 69, pl. ix, figs. 3*a*, *b* (2*a*, *b* ?).

DIAGNOSIS. Ceratitids, apparently of the *nodosus*-group, with costation continuous across the venter, and therefore resembling *Acrochordiceras*, Hyatt. Suture-line ceratitic, with slender saddles.

DISTRIBUTION. Meso-trias, Anisian. Himalayas.

REMARKS. The holotype of the species, here reproduced as fig. 156, seems to me to be a malformation. Whether it is a deformed example of the same species as the paratype (Diener's, figs. 2*a*, *b*), however, is quite uncertain. The latter was described as having more uniform ribs that are thickest, not on the

venter, but at the ventro-lateral edges; also having less closely ribbed inner whorls. Simionescu (1913, pp. 288, 350, pl. ix, fig. 1) figured and described as *Ceratites*? (*Peripleurocyclus*) cfr. *smithianus* a Rumanian fragment that is altogether doubtful, so that the affinities of the present genus are as yet far from clear.

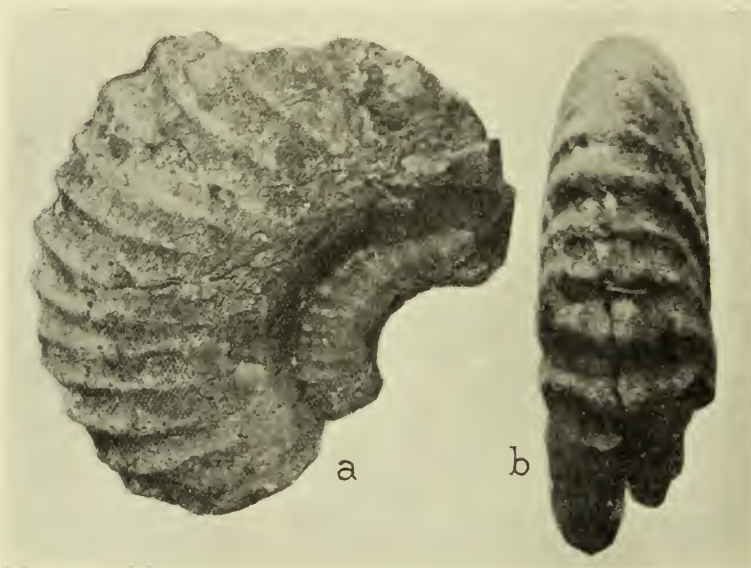


FIG. 156.—*Peripleurocyclus smithianus*, Diener. Side- and peripheral views of holotype. Middle Trias. Himalayas. (After Diener, 1907, pl. ix, figs. 3a, b.)

Genus **PROGONOCERATITES**, Schrammen, emend.

1928, p. 35.

GENOTYPE. *Ceratites atavus*, Philippi, 1901, p. 393, pl. xxxiv, figs. 1, 1a, b.

DIAGNOSIS. Generally compressed Ceratitidæ, resembling discoidal *Ceratites*, with ornamented inner whorls and more-or-less smooth body-chambers.

RANGE. Lower Ceratite Beds, Upper Muschelkalk, Upper Meso-trias, Ladinian. Germany; France.

REMARKS. It has already been mentioned that we cannot accept Schrammen's view of the hypothetical acquisition of

shells by originally shell-less cephalopods, and the consequent replacement of stock after stock in the Ammonoidea by newly-arisen, shell-bearing groups. His nomenclature cannot be so easily ignored, and if subdivision of the now very cumbersome genus *Ceratites* of the Germanic Muschelkalk be attempted, it becomes necessary to select one from among Schrammen's numerous names. In the circumstances it seems advisable to



FIG. 157.—*Progonoceratites atavus* (Philippi). Side- and two peripheral views of lectotype. Upper Muschelkalk, Thuringia. (After Philippi, 1901, pl. xxxiv, figs. 1, 1a, b.)

adopt his first genus *Progonoceratites* for those early forms in which the *Paraceratites*-like ornamentation is confined to the inner whorls. Of course, there are numerous passage-forms from this to the restricted *Ceratites*, that is, the spinose and nodose forms which occur in the next higher beds, in which strong ornamentation persists as far as the body-chamber, which is generally very robust and inflated. Similarly, *Discoceratites*, here adopted for the last and discoidal, smooth *Ceratites* of the highest beds of the Upper Muschelkalk, is connected with the others by numerous transitions, but in its typical forms is distinct enough for generic separation.

Progonoceratites atavus still shows resemblance to *Paraceratites binodosus* and *P. trinodosus* of the Alpine Anisian,

as Philippi (1901, p. 439) pointed out. This author, however, held, then, and again in 1903 (p. 25), that the *Ceratites* of the Upper Germanic Muschelkalk had no phylogenetic connection with the solitary form of the lower division (*Ceratites antecessens*). Riedel (1918, p. 80) also thought this relationship very uncertain, but, despite Diener's (1905a) unfruitful labours, expected better results from a study of the inner whorls. He noticed, however, that a variety of forms had erroneously been included in the one species, *C. antecessens*. Although the true *C. antecessens*, Beyrich (1858, p. 211, pl. iv, fig. 4; 1867, p. 112, pl. iv, fig. 3), is a *Paraceratites* in our meaning, some of the Wurtemberg forms that have been included in that species are undoubtedly close to *Progonoceratites*. Thus Schmidt (1907b, p. 533) connected *Ceratites antecessens* with *Progonoceratites flexuosus*, which is close to *P. atavus*; and a cast of the fragment (C. 31325), figured by that author in another paper (1907a, pl. ii, fig. 6), not only greatly resembles *Progonoceratites*, but also shows that his Wellenkalk form is at least specifically distinct from Beyrich's species. A cast of another complete example (C. 31324) of a so-called *Ceratites antecessens* from Dietersweiler, in the Natural History Museum of Stuttgart, comparable to Schmidt's (1928) fig. 811a, p. 295, also seems to suggest a transition from *Paraceratites* to *Progonoceratites*; but, as already mentioned, it is more probable that the German *Ceratites* of the Upper Muschelkalk, as well as their local variants or representatives known from Toulon, Catalonia, Sardinia and the Dobrudgea, are descendants of the same Ceratitid stock that produced *Frechites* as well as *Paraceratites*.

Progonoceratites atavus (Philippi).

Fig. 157, p. 467.

- 1901, p. 393, pl. xxxiv, figs. 1, 1a, b (2, 3); Diener, 1915a, p. 78;
Riedel, 1918, p. 18; pl. i, figs. 1, 2; Schrammen, 1928, p. 36;
M. Schmidt, 1928, p. 296, text-fig. 813; Kutassy, 1933, p. 443.

DIAGNOSIS. Platygyral, subleptogyral, subangustumbilicate, *Progonoceratites*. Whorl-section compressed, sides slightly convex, venter sub-tabulate. With 10-12 lateral tubercles, and about twice as many outer clavi. With signs of sigmoidal striation, but no ribbing. Suture-line ceratitic, with comparatively deep lobes.

MEASUREMENTS :

Lectotype (Philippi)	. 56	. 51	. 30	. 20
Riedel (pl. i, fig. 1)	. 52	. 52	. 34	. 15

REMARKS. This is one of the most primitive and earliest of the Ceratites of the Upper Muschelkalk, and I believe that Philippi was right in considering it to be closer to the Alpine *Paraceratites binodosus* than to the typical *Ceratites nodosus* of higher beds. In spite of Schrammen's view to the contrary, there are numerous variations and transitions, and the genealogical tree of the Germanic Ceratites suggested by Riedel (*loc. cit.*, p. 70), if perhaps incorrect in details, probably represents the true position of the present species as one of the root-stocks of the later forms. *Progonoceratites sequens* (Riedel) and *P. flexosus* (Philippi) are closely related species, and their separation into distinct series or genera (in Schrammen) is to be deprecated.

HORIZON AND LOCALITIES. Upper Meso-trias, Upper German Muschelkalk (*atavus* zone of the Lower Ceratite Beds). Germany.

SPECIMENS :

- C. 14764. Diemarden, nr. Göttingen. *Exchange*, 1906.
 C. 14777. Flütenweg, nr. Göttingen. *Exchange*, 1906.
 C. 28750. Königsdahlum, nr. Bokenem.
 A. Schrammen Coll. Purchased, 1926.
 C. 28744, C. 28742 (?). Wesseln, nr. Hildesheim.

Same Coll.

The Collection also includes casts of the originals of Philippi's plate xxxiv, fig. 1 (the holotype, C. 31331), Riedel's plate i, fig. 1 (C. 31333), and of a Dornstetten example in the Naturalien-sammlung at Stuttgart (C. 31332).

***Progonoceratites sequens* (Riedel).**

1918, p. 20, pl. i, figs. 3 (lectotype), 4 ; Stolley, 1918, p. 124 ; Schrammen, 1928, p. 36 ; M. Schmidt, 1928, p. 296, text-fig. 814.

DIAGNOSIS. Like *P. atavus*, but with greater whorl-thickness and growing to a larger size (max. 90 mm.).

MEASUREMENTS :

Lectotype	. 80	. 51	. 32	. 15
Riedel, pl. i, fig. 4	. 90	. 47	. (30 ?)	. 18

REMARKS. Riedel gave the whorl-height as 48% of the diameter ; but the above measurements, taken from a cast

of the lectotype (C. 31327), show 51%. In the var. *orbata*, Stolley, also represented by a cast of the original (C. 31328), the whorl-section is less inflated and the umbilicus is wider, while there is complete loss of ornamentation. This smooth variety shows great resemblance to several similar offshoots of later *Ceratites*.

HORIZON AND LOCALITIES. Upper Meso-trias, Upper Muschelkalk, Lower Ceratite Beds. Germany.

SPECIMENS :

C. 28759. Steuerwald, near Hildesheim.

Dr. A. Schrammen Coll. Purchased, 1926.

***Progonoceratites primitivus* (Riedel).**

1918, p. 23, pl. ii, fig. 2 (lectotype), 1; Schrammen, 1928, p. 37 (*Caloceratites*); M. Schmidt, 1928, p. 297, text-fig. 816.

DIAGNOSIS. Like *P. atavus*, but with a more inflated, trapezoidal whorl-shape, and more pronounced ornamentation. Suture-line with broader and shallower lobes.

MEASUREMENTS :

Lectotype	.	.	.	52	.	50	.	38	.	14
Riedel, pl. ii, fig. 1	.	.	.	44	.	46	.	?	.	21

REMARKS. The inner whorls in this species have a bi-nodose ornamentation, but at larger diameters (maximum about 60 mm.) the lateral tubercles may move almost up to the middle of the side. In comparable forms of *Frechites* the ribs are much stronger in proportion and the outer tubercles weaker. *P. primitivus* is difficult to distinguish from immature examples of later and larger *Ceratites*, e. g. *C. pulcher*. These may show similar ornamentation, but are generally more evolute and the tubercles are less closely set.

The Diemarden example listed below is transitional to *P. atavus*, and resembles *Ceratites* ex. aff. *atavi*, Philippi (1901, pl. xxxiv, fig. 4), of which the Museum also has a cast (C. 31330).

HORIZON AND LOCALITIES. Upper Meso-trias, Upper Muschelkalk, Lower Ceratite Beds. Germany.

SPECIMENS :

C. 31329. Hengstbach (Trochitenkalk). (Cast of Philippi's original, pl. xxxvii, fig. 3 = *Ceratites* sp.).

Exchange, Dr. Berckhemer, 1928.

C. 14765. Diemarden, nr. Göttingen.

Exchange, E. Mascke, 1906.

Progonoceratites flexuosus (Philippi).

1849, v. Buch, p. 5, pl. v, fig. 2 (*Ceratites nodosus partim*); 1901, Philippi, p. 395, pl. xxxiv, fig. 5 (6 ?); pl. xxxv, figs. 1-4; 1915a, Diener, p. 82; 1918, Riedel, p. 20; 1928, Schrammen, p. 36 (*Campyloceratites*); 1928, Schmidt, pp. 296, 297, text-fig. 815.

DIAGNOSIS. Platygyral, subpachygyral, angustumbilicate *Progonoceratites*. Whorl-section polygonal in young, compressed sub-elliptical in adult. Inner and outer tubercles as in *P. atavus*, in addition to strongly sigmoidal lines of growth of varying intensity. Tubercles lost on body-chamber. Suture-line similar to that of *P. atavus*, with the toothing of the lobes tending to encroach on the saddles, as in *Paraceratites*.

MEASUREMENTS :

V. Buch (holotype)	.	.	54	.	·52	.	·35	.	·17
Philippi (pl. xxxv, fig. 1)	.	.	80	.	·52	.	·35	.	·17
Riedel, 1918, p. 21	.	.	—	.	·52	.	·35	.	—

REMARKS. V. Buch's original, examined and re-figured by Philippi, must be taken as type. There are only two poorly preserved examples in the Collection, but there are casts of the typical specimens figured by Philippi in his pl. xxxiv, fig. 5 (C. 31427), pl. xxxv, fig. 1 (C. 31428), and pl. xxxv, fig. 4 (C. 31429), the last being v. Buch's original. The Museum also possesses casts of the *Ceratites* sp. ex. aff. *flexuosi* figured by Philippi in pl. xxxiv, figs. 6, 6a (C. 31430), and of Riedel's *P. flexuosus* var. *crassa* (1918, pl. i, fig. 5, C. 31431). Schrammen's "*Campyloceratites*" for the *flexuosus*-group is not here adopted; moreover, specimens from his collection, labelled *Cer. flexuosus*, are not believed to belong to this species.

HORIZON AND LOCALITIES. Upper Meso-trias, Upper Muschelkalk, Lower Ceratite Beds (*atavus* zone). Germany.

SPECIMENS :

C. 14760, 14772. Diemarden, near Göttingen.

Exchange, E. Mascke, 1906.

(?) **1616.** Leineck, Bavaria. (?) **C. 31153.** Locality unrecorded.

Dr. Braun Coll., 1839.

Progonoceratites discus (Riedel).

1918, p. 24, pl. ii, figs. 3 (lectotype), 4, 5; Stolley, 1918, p. 125, pl. xix, fig. 1; Schrammen, 1928, p. 37 (*Caloceratites primitivus*); Schmidt, 1928, p. 297, fig. 817.

DIAGNOSIS. Like *P. sequens*, but with flatter sides and a more

rectangular whorl-section, also stronger ornamentation, but becoming quite smooth towards end of body-chamber.

MEASUREMENTS :

Lectotype	80	. 50	. (30 ?)	. 15
Stolley, pl. xix, fig. 1	87	. 46	. (?)	. 20

REMARKS. The Collection includes a cast of Stolley's large example (pl. xix, fig. 1, C. 31433), also a cast (C. 31432) of the unlocalized example figured by Philippi (1901, pl. xxxvi, fig. 2) as *Ceratites* sp. ind., which was considered by Riedel to be more appropriately classed with *P. discus* than with *Ceratites compressus*. The examples in the Collection are all slightly different from one another, and in view of their imperfect preservation, might well have been included with the other closely related species.

HORIZON AND LOCALITIES. Upper Meso-trias, Upper Muschelkalk, Lower Ceratite Beds (*discus* zone). Germany.

SPECIMENS :

C. 31123. Locality unrecorded. *Old Coll.*

C. 28747-8. Nette, nr. Bokenem, Hanover.

Dr. A. Schrammen Coll., 1926.

C. 28756. Kreiensen, Hanover.

Same Coll.

(?) **C. 14775.** Molkengrund, Hainberg, nr. Göttingen (labelled *C. ex. aff. enodis*, Que.). *Exchange, E. Mascke, 1906.*

(?) **C. 28727.** Iber, nr. Edesheim, Hanover (labelled *C. lævigatus*).
Dr. A. Schrammen Coll., 1926.

***Progonoceratites pulcher* (Riedel).**

1918, p. 25, pl. ii, figs. 6 (lectotype), 7 ; pl. iii, fig. 1 (2, 3 ?) ; pl. xviii, fig. 4 ; Stolley, 1918, p. 125, pl. xix, fig. 6 ; Schrammen, 1928, p. 37 (*Caloceratites*) ; Schmidt, 1928, p. 297, text-fig. 818.

DIAGNOSIS. *Progonoceratites* resembling *P. primitivus* and derived from it, but with larger umbilicus and greater whorl-thickness and generally of larger size (maximum 80 mm.).

MEASUREMENTS :

Riedel, p. 25 (average)	65	. 43	. 34	. —
Stolley, pl. xix, fig. 6.	60	. 45	. 36	. 25

REMARKS. The second set of measurements was taken from a cast of Stolley's original from Uehrde, re-figured by Schmidt (C. 31434), which is said to be typical. The collection also includes a cast (C. 31435) of the variety figured by Riedel in

pl. iii, fig. 3, with coarser ornamentation and a high umbilical wall. These varieties lead to *Ceratites robustus*, Riedel, whilst weakening of the tuberculation and ribbing produces passage-forms to *P. lævis*, described below.

HORIZON AND LOCALITIES. Upper Meso-trias, Upper Muschelkalk, Lower Ceratite Beds (*pulcher* and *atavus* zones). Germany.

SPECIMENS :

C. 28743. Wesseln, near Hildesheim. *A. Schrammen Coll.*, 1926.

C. 28745. Nethe, near Bokenem, Hanover. *Same Coll.*

C. 28749. Königsdahlum, near Bokenem, Hanover. *Same Coll.*

C. 28757-8. Kreiensen, Hanover. *Same Coll.*

(These two specimens were labelled *C. flexuosus*, but may also be included here.)

C. 2975 (?), **74310 (?)**. Localities unrecorded. *Old Coll.*

***Progonoceratites lævis* (Riedel).**

1918, p. 27, pl. iii, figs. 5, 5a (lectotype), 4; Stolley, 1918, p. 125; Schrammen, 1928, p. 37 (*Leioceratites*); Schmidt, 1928, p. 298, fig. 819.

DIAGNOSIS. Like *P. pulcher*, but with more-or-less pronounced loss of ornamentation.

MEASUREMENTS :

Riedel, pl. iii, fig. 5	.	.	67	·42	·31	·26
„ pl. iii, fig. 4	.	.	72	·47	·32	·20
„ (text)	.	.	(75)	·44	·25	(?)

REMARKS. The second set of measurements was taken from a cast of Riedel's original (C. 31436), but there is considerable variation, and Riedel records the occurrence of more compressed individuals. There are numerous transitions, both to *P. pulcher*, and apparently to such more involute forms as *P. flexuosus* and *P. atavus*. The form figured by Riedel in pl. iii, fig. 4, was, indeed, described by Stolley as a transition from *P. flexuosus* to *P. lævis*. In spite of the fact that the limits of the present form are thus somewhat theoretical, I agree with Stolley (p. 126) in advocating the use of separate names for the similar, smooth forms of different horizons.

HORIZON AND LOCALITIES. Upper Meso-trias, Upper Muschelkalk, Lower Ceratite Beds (*pulcher* and *atavus* zones). Germany.

SPECIMENS :

C. 31436. Königslutter, on the Elm. (Cast of original in the Collection of the Technische Hochschule, Brunswick.)
Exchange, Prof. Berckhemer, 1928.

Progonoceratites philippii (Riedel).

1918, p. 30, pl. vi, figs. 4 (lectotype), 1, 2, 3; Stolley, 1918, p. 127, pl. xix, fig. 5; Schrammen, 1928, p. 37 (*Hadroceratites*); Schmidt, 1928, p. 299, text-fig. 822.

DIAGNOSIS. Like *P. laevis*, but entirely smooth, and less involute.

MEASUREMENTS :

Riedel, p. 30 (average) . . .	80	·40	·32	(?)
„ pl. vi, fig. 4 . . .	80	·41	·24	·26

REMARKS. Stolley drew attention to the heterogeneous nature of the forms included in the present species, but Riedel definitely stated that the typical *P. philippii* was devoid of all sculpture, and that it differed from *P. laevis* merely in a slower rate of growth and smaller involution. This clearly indicates that fig. 4 should be chosen as the lectotype, although this extreme is rare. In the more inflated var. *rotunda*, Riedel (pl. vii, fig. 1), of which the Collection includes a cast (C. 31438), the ornamentation of the inner whorls suggests connection with *P. pulcher* and allies. On the other hand, Stolley's example (also represented by a cast, C. 31437), as well as forms like Riedel's fig. 2, pl. vi, are transitional from *Progonoceratites* to *Ceratites robustus*. The two examples listed below are not typical. One was labelled by Dr. Mascke "*Ceratites* sp. ind. I, Philippi, pl. xxxvi, fig. 1", which is included by Riedel in his *P. discus*; but the inflated, smooth and round body-chamber of this specimen suggests reference to the var. *rotunda* of the present species. The other example is more compressed than the original of this variety, and differs from such forms as *P. discus* (Riedel, pl. ii, fig. 4) merely in its larger umbilicus.

HORIZON AND LOCALITIES. Upper Meso-trias, Upper Muschelkalk, Lower Ceratite Beds (*pulcher* and *atavus* zones). Germany.

SPECIMENS :

C. 14769. Mensingberg, near Reinhausen (Göttingen).

Exchange, E. Mascke, 1906.

C. 26124. Erkerode, near Brunswick.

J. F. Blake Coll., 1907.

Genus **CERATITES**, de Haan.

1825, p. 39 (= "*Symboloceratites*", Schrammen, 1928, p. 41).

GENOTYPE. *Ammonites nodosa*, Bruguière, 1792, p. 43 (= *Corne d'ammon*, etc., Bourguet, 1742, pt. 2, p. 70, pl. xxxix, fig. 262).

DIAGNOSIS. More-or-less evolute, robust Ceratitidæ, with coarse ornamentation, generally persisting to end, and with ceratitic suture-line.

RANGE. Upper Meso-trias, Ladinian, Middle and Upper Muschelkalk. Germany; France; Spain; Sardinia; Rumania.

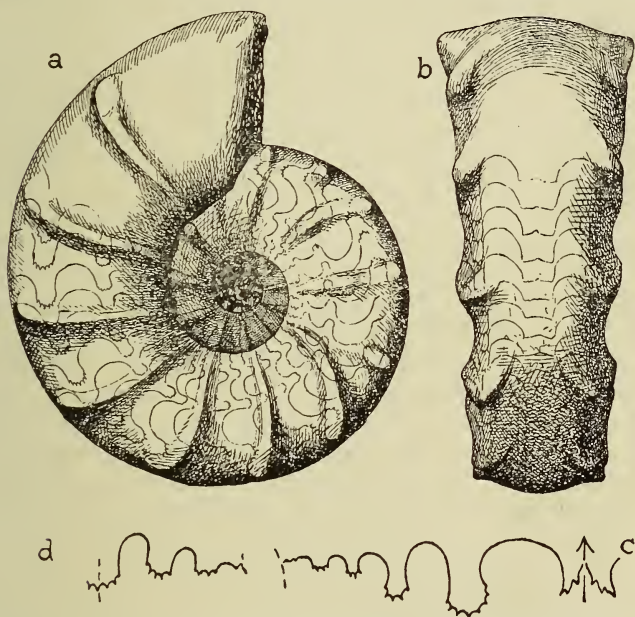


FIG. 158.—a-c, *Ceratites nodosus* (Bruguière). Side- and peripheral views (reduced) and external suture-line of an Upper Muschelkalk example. Würzburg, Bavaria. (After Zittel, 1884, p. 428, text-figs. 591a-c.) d, Internal suture-line of a Thuringian example (after Philippi, 1901, p. 354, text-fig. 2, wrongly restored [see Benecke, 1916, pl. xii]).

REMARKS. When establishing the genus *Ceratites*, de Haan (1825, pp. 39, 157) listed Bruguière's species only in the second place, but he cited in the synonymy, among others, Knorr and Walch's pl. ia, fig. 5, which may be taken to represent the true *Ceratites nodosus*, as now restricted.

He made no reference to Schlotheim's incorrect figure, which was first published in 1823, and was again reprinted in 1832. Mojsisovics (1882, p. 18) has already met the objections that could be raised on account of de Haan's first mentioning the Neocomian *Ammonites radiatus*, Bruguière, so that *Ceratites nodosus*, indeed, stands as the genotype. Also, with Mojsisovics

we must consider *Haaniceras*, Bayle, 1878, synonymous with *Ceratites*, since the use of the latter name by Tournefort (for a plant) does not affect its application to a group of mollusca.

As now restricted, *Ceratites* includes only those derivatives of *Progonoceratites* in which the tuberculation is coarse, and generally changes on the outer whorl into blunt, lateral ribs, instead of declining, as in the earlier genus. The transition, however, from *Progonoceratites* to *Ceratites* did not take place along a single line of development, and there are various passage forms, like the transitional links between *Ceratites robustus* and *Progonoceratites philippii* already referred to (p. 474), that might be included in either genus.

Riedel's "Formenkreis des *Ceratites compressus-nodosus*" does not quite correspond to the restricted genus *Ceratites*, as here understood, but this is due chiefly to his placing of *C. robustus* with the earlier (*atavus*) assemblage. This species, however, is admittedly connected by transitions with *Ceratites compressus*. It might be held that the small group of spinose *Ceratites* could conveniently be separated as *Hoploceratites*, Schrammen (including "*Echinoceratites*" and "*Acanthoceratites*", Schrammen), but many typical nodose *Ceratites* s.s. develop outer nodes, and there is such great variability that the separation of this group would offer no practical advantage.

***Ceratites nodosus* (Bruguière).**

1792, p. 43; Diener, 1915a, p. 86; Riedel, 1918, p. 46, pl. xi, fig. 2; Schrammen, 1928, p. 41 (*Symboloceratites*); Schmidt, 1928, p. 303, text-fig. 835.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Ceratites*. Whorl-section sub-quadrate, with gently convex venter and flattened, slightly divergent sides. Bi-nodose ornamentation in the young, changing into strong, blunt and slightly curved ribs that may form a distinct node at the peripheral end; about seven on the last half-whorl. Suture-line ceratitic (see fig. 158c, p. 475), with wide and low external saddle.

MEASUREMENTS :

Philippi, pl. xlvii, fig. 1	.	145	.	44	.	41	.	26
„ (text)	.	—	.	42	.	35	.	(?)
„ pl. xlvii, fig. 1	.	118	.	42	.	46	.	29
„ pl. xlvii, fig. 2								
(var. <i>minor</i>)	.	113	.	49	.	44 (?)	.	20
Riedel, p. 47	.	155	.	42	.	37	.	(?)

REMARKS. Philippi has shown that Bourguet's figure, cited by Bruguière, even if only a bad copy of Scheuchzer's original (1718, p. 259, fig. 25), undoubtedly represented the true German *Ceratites nodosus*; also that Baier's (1757, pl. ii, fig. 4) *Ammonis cornu verrucosa*, mentioned by Bruguière in the first place, was (according to Quenstedt) a typical Upper Jurassic "*perarmatus*", and in any case has a suture-line that is anything but ceratitic. We do not thus follow authors in writing *Ceratites nodosus* (Bruguière), Schlotheim, sp. (Schmidt, 1928, p. 303), or in attributing the species definitely to Schlotheim (Schrammen, 1928, p. 41). This author, however, figured (1823, pl. xxxi, fig. 1) a specimen (although with incorrectly drawn suture-line) of the form to which Philippi (1901, p. 413) restricted the name *C. nodosus*. Since neither Scheuchzer's nor Schlotheim's originals can be traced, the specimen figured by Philippi (1901, pl. xlvii, figs. 1, 1a, b) may be considered to be the neotype.

The Collection includes a cast of Philippi's smaller example (pl. xlvii, fig. 1 = No. 3 of the above measurements, C. 31439), also of the original of his fig. 3 of the same plate (C. 31441), and the two examples of *Ceratites nodosus minor* figured in pl. xlvii, fig. 2 (C. 31442) and pl. xlviii, fig. 1 (C. 31443). The latter form was characterized as differing from the type chiefly in being more involute and in having more numerous, but less prominent, ribs on the body-chamber. There are, however, many transitions between the two forms, and Riedel (1918, p. 49) was right in considering that Philippi's separation of the two was not particularly successful. The Collection also includes some examples of over 200 mm. diameter that have been separated (Benecke, 1911) as *Ceratites nodosus major*.

C. hercynus, Riedel (1918, p. 50, pl. xii, fig. 1), which was described as closely allied to *C. nodosus*, is represented in the Collection only by a cast of Riedel's holotype (C. 31687).

HORIZON AND LOCALITIES. Middle Trias, Upper Muschelkalk, Upper Ceratite Beds. Germany and France.

SPECIMENS :

- | | |
|--|--------------------------------------|
| 46481. Hanover. | Saull Coll., 1863. |
| 50175, 50177. Brunswick. | Prof. J. Morris Coll., 1867. |
| C. 366 (?). Brunswick. | Sir P. de M. G. Egerton Coll., 1882. |
| C. 14780, C. 10893-4. Versbach, nr. Würzburg, Bavaria. | Exchange, E. Mascke, 1906. |
| C. 21718. Würzburg, Bavaria. | Old Coll. |

C. 21963. Sulz-les-Bains, Bas-Rhin, France.

Geol. Soc. Coll., 1911.

C. 28702, 28719. Sultemerberg, nr. Northeim.

A. Schrammen Coll., 1926.

C. 28708. Bremsbahn, Meissner.

Same Coll.

C. 28724, 28725. Iber, nr. Edesheim, Hanover.

Same Coll.

C. 31154, 31156, 31157, 31158. No locality.

Old Coll.

C. 31164. Hall, Germany.

Old Coll.

C. 31167. Crailsheim, Wurtemberg.

Old Coll.

C. 31470-71, 31472 (?). Weimar, Germany.

Presented C. Westendarp, 1884.

898 (var. *minor*). Würzburg, Bavaria.

Dr. Krantz, 1838.

36245 (var. *minor*). Würzburg, Bavaria.

Old Coll.

36246 (var. *minor*). Brunswick.

Old Coll.

1630 (var. *minor*). Bindloch, Bavaria.

Dr. Braun Coll., 1839.

C. 828 (var. *minor*). Locality unrecorded.

J. S. Gardner, 1885.

C. 28703, 28718, 28720 (var. *minor*). Sultemerberg, nr. Northeim, Hanover.

A. Schrammen Coll., 1926.

C. 31152 (var. *minor* or transition to *C. hercynus*?). Locality unrecorded.

Old Coll.

36244. Wurtemberg.

Old Coll.

C. 14784. Versbach, near Würzburg, Bavaria.

Exchange, E. Mascke, 1906.

C. 28706. Ungsterode, Meissner, Hanover.

Dr. A. Schrammen Coll., 1926.

(The last three [so-called "*C. intermedius*"] are transitional between the var. *minor* and *C. levalloisi*, discussed below.)

Ceratites robustus, Riedel.

1918, p. 28, pl. iv, figs. 2, 2a (lectotype), 1, 3-5; pl. v, figs. 1, 3; pl. vi, fig. 1; Stolley, 1918, p. 127, pl. xix, fig. 7; Schrammen, 1928, p. 37 (*Hadroceratites*); Schmidt, 1928, p. 298, text-fig. 820.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Ceratites*, resembling *Progonoceratites pulcher* (of which it represents a larger and typically later development), but with bi-nodose sculpture of the chambered whorls replaced on the body-chamber by short and highly projecting bulges, with often pseudo-constrictions between. Suture-line typically ceratitic.

MEASUREMENTS :

Riedel, pl. iv, figs. 2, 2a	. 75	. 40	. 40	. 29
„ (text)	. 75	. 40	. 32	(?)

REMARKS. Fig. 2a of Riedel's pl. iv is wrongly marked 5a. The Collection includes a cast (C. 31444) of the original of fig. 5, and since its opposite side is corroded, it is obvious that the peripheral view 5a belongs to that individual (fig. 2) which is chosen as lectotype. The specimen represented in fig. 5, however, also has a whorl-section that is considerably more inflated (measured at the bulges) than the proportion (32%) given by Riedel suggests. In Stolley's specimen (of which there is also a cast, C. 31445) at 60 mm. diameter the whorl-thickness is similarly still equal to the whorl-height.

Increase in the size of the tuberculation leads to the var. *horrida*, Riedel, and the Collection comprises a cast (C. 31446) of a typical example from Göttingen in the Naturaliensammlung at Stuttgart. There is also a cast (C. 31447) of the original of the var. *rarinodosa*, Riedel (pl. v, fig. 5), with unusually distant and persisting lateral bulges, and, as Stolley observes, this variety is close to the younger *C. raricostatus*, Riedel, 1918, p. 33, pl. vii, fig. 4). This last species is unfortunately represented only by a cast of the type (C. 31448), as is the var. *romanica* (Tornquist) figured in Riedel (1918, pl. vii, fig. 2) as *Ceratites romanicus* (C. 31451). The last leads to *C. riedeli*, described below.

HORIZON AND LOCALITIES. Middle Trias, Lower Ceratite Beds. Germany.

SPECIMENS :

23951. Würzburg, Bavaria. *Purchased, 1849.*

C. 14757-8. Diemarden, nr. Göttingen.

Exchange, E. Mascke, 1906.

C. 14770. Mensingberg, nr. Göttingen.

Exchange, E. Mascke, 1906.

C. 28746. Nette, nr. Bokenem, Hanover.

Dr. A. Schrammen Coll., 1926.

C. 28732-33. Neuhoof, nr. Hildesheim.

Dr. A. Schrammen Coll., 1926.

Ceratites lævigatus, Philippi.

1901, p. 408, pl. xlv, figs. 1, 1a (lectotype), 2, 2a, b; Diener, 1915a, p. 84; Riedel, 1918, p. 33, pl. viii, figs. 1-3; Schrammen, 1928, p. 40 (*Cycloceratites*); Schmidt, 1928, p. 299, text-fig. 824.

DIAGNOSIS. Like *C. robustus*, but with ornamentation weakening or disappearing on outer whorl.

MEASUREMENTS :

Lectotype (Philippi, pl. xlv,

fig. 1)	.	.	.	120	.	·39	.	·28	.	·33
Riedel, p. 33	.	.	.	105	.	·41	.	·28	.	—

REMARKS. This rare form grows to a larger size (125 mm.) than *C. robustus*, and is distinguished from it and the closely allied *C. varicosatus* by its nearly smooth outer whorl. The Collection includes a cast of the lectotype (C. 31449) and of a specimen from Widdern in the Naturaliensammlung of Stuttgart (C. 31450), in addition to the examples listed below.

HORIZON AND LOCALITIES. Upper Meso-trias, Upper Muschelkalk, Lower Ceratite Beds. Germany ; France.

SPECIMENS :

C. 14755, 14761. Diemarden, near Göttingen.

Exchange, E. Maschke, 1906.

C. 14753 (?). Same locality and coll. (labelled *C. aff. spinosus*).

C. 14756 (?). Same locality and coll. (labelled *C. aff. enodis*).

C. 28726, 28728. Iber, near Edesheim, Hanover.

Dr. A. Schrammen Ccell., 1926.

Ceratites enodis, Quenstedt.

Diener, 1915a, p. 81 ; Riedel, 1918, p. 44, pl. xi, fig. 1 ; Stolley, 1918, p. 132 ; Schrammen, 1928, p. 40 (*Gymnoceratites*) ; Schmidt, 1928, p. 302, text-fig. 834 (p. 303).

DIAGNOSIS. *Ceratites* resembling *Progonoceratites lævis*, *P. philippii* and *C. lævigatus*, but more evolute and larger than the former two, and without the lateral folds of the earlier whorls of the latter.

MEASUREMENTS :

Quenstedt, 1846, pl. iii, fig. 15	101	·38	[·26 ?]	·32
Philippi, 1901, pl. xlv, fig. 1				
(and text)	108	·41-·43	·24-·29	·27

REMARKS. The generally accepted interpretation of Quenstedt's incompletely known species as a degenerate form, comparable to the earlier *Progonoceratites lævis* and *P. philippii*, is here adopted, and it is thus left in the genus *Ceratites* s.s., although Riedel's genealogical tree of the *Ceratites* (p. 70) suggests that *C. enodis* might be the root-form of *Discoceratites*.

The Collection includes casts of the specimens (C. 31685-6) figured by Philippi (1901, pl. xlv, figs. 1 and 3), also an interesting example (C. 28730) from Neuhoof, near Hildesheim, sent by Dr. A. Schrammen as *Ceratites enodis*, which has slight lateral bulges and cannot be satisfactorily distinguished from the earlier *Progonoceratites lævis*, Riedel. It may be a passage form from *C. lævigatus* to the more degenerate *C. enodis*.

HORIZON AND LOCALITIES. Upper Middle Trias, Upper Muschelkalk, Middle Ceratite Beds. Germany.

SPECIMENS :

C. 14751, 14771. Diemarden, nr. Göttingen.

Exchange E. Mascke, 1906.

? **C. 28730.** Neuhoof, nr. Hildesheim.

Dr. A. Schrammen Coll., 1926.

***Ceratites muensteri*, Diener.**

1900, p. 9 (= nom. nov. for *Ceratites subnodosus*, Muenster, 1831, p. 372); 1915a, p. 85; Riedel, 1918, p. 35, pl. viii, fig. 4; pl. xiii, fig. 3; Stolley, 1918, p. 133, pl. xix, figs. 12, 12a; Schrammen, 1928, p. 39 (*Doloceratites*); Schmidt, 1928, p. 299, text-fig. 825, p. 300.

DIAGNOSIS. Like *C. robustus*, but with wide and flat venter, and external spines that persist on the body-chamber.

MEASUREMENTS :

Philippi, pl. xxxix, fig. 1	. 68	·46	. (·42 ?)·40	. ·25
Stolley, pl. xix, fig. 12	. 73	·47	. 37 (?)	. ·25

REMARKS. This rare species may easily be confused with the inner whorls of certain spinose *Ceratites*, and in the absence of the body-chamber correct identification is probably impossible. The Collection includes casts of Stolley's figured example in Brunswick (C. 31452) and of a typical specimen from Weissach in the Stuttgart Museum (C. 31453). There are also numerous *Ceratites*, originally labelled *C. muensteri*; but only very few are now left in this species. Some, by their narrower venters, and the appearance of folds on the body-chamber, are clearly referable to *C. robustus*; others are discussed below and embedded (with other fossils) in large slabs of rock, the preservation of which, perhaps, is not sufficiently good for accurate specific determination of the *Ceratites*.

HORIZON AND LOCALITIES. Upper Muschelkalk, Middle Ceratite Beds (*spinusus* zone). Germany.

SPECIMENS :

C. 14759. Diemarden, near Göttingen.

Exchange, E. Mascke, 1906.

C. 28751-2, 28753a, b. Königsdahlum, nr. Bokenem, Hanover
(Feldweg). *Dr. A. Schrammen Coll., 1926.*

C. 28709a-c. Neuhoof, nr. Hildesheim. *Same Coll.*

Ceratites riedeli, Stolley.

1918, p. 135, pl. xix, figs. 10, 10a, 11; 1928, Schrammen, p. 39
(*Doloceratites*); 1928, Schmidt, p. 300, text-fig. 826.

DIAGNOSIS. Like *C. muensteri*, but with venter remaining narrow.

MEASUREMENTS :

Lectotype (Stolley, pl. xix, fig. 10)	80	·44	·30 ?	·23
C. 28731	60	·42	·30 ?	·25

REMARKS. This species is represented in the Collection by a cast (C. 31455) of the lectotype from Eystedt in the Museum of the Technische Hochschule, Brunswick, and by two doubtful examples, labelled "*Ceratites muensteri*", which differ from that species in their decreased whorl-thickness. It is possible that they are transitions to the more compressed forms of *C. robustus*, e. g. the "*Ceratites* aff. *muensteri*" (C. 14757-8) listed above, but in their more clavate outer spines on the earlier part of the body-chambers they resemble *C. riedeli*.

HORIZON AND LOCALITIES. Upper Muschelkalk, Middle Ceratite Beds (*spinosus* zone). Germany.

SPECIMENS :

C. 14763. Diemarden, near Göttingen. ("*Ceratites* n. sp. aff. *muensteri*."). *Exchange, E. Mascke, 1906.*

C. 28731. Neuhoof, near Hildesheim.
Dr. A. Schrammen Coll., 1926.

Ceratites humilis, Philippi.

1901, p. 73, pl. xli, fig. 2; Diener, 1915a, p. 83; Riedel, 1918, p. 37; Stolley, 1918, p. 135; Schrammen, 1928, p. 40 (*Nannoceratites*); Schmidt, 1928, p. 300, text-fig. 827.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Ceratites*. Whorl-section quadrate, venter broad and flat.

With bi-nodose ornament as in *C. muensteri*, but persisting on body-chamber, and with the inner spines elongated towards umbilical suture, and bulging.

MEASUREMENTS :

Holotype 72 . 43 . 38 . 30

REMARKS. The dimensions of this rather small and very rare species were taken from a cast of the holotype (C. 31454) in the University Museum of Göttingen. The doubtful example listed below and referred by Dr. A. Schrammen to the present species is still septate at 70 mm. diameter.

HORIZON AND LOCALITIES. Upper Muschelkalk, Middle Ceratite Beds (*spinosus* zone). Germany.

SPECIMENS :

- (?) **C. 28760.** Steuerwald, near Hildesheim (labelled *nodosus* zone). Dr. A. Schrammen Coll., 1926.

Ceratites compressus, Sandberger-Philippi, em. Riedel.

1915a, Diener, p. 80 ; 1918, Riedel, p. 38, pl. ix, figs. 2-6 ; pl. x, fig. 1 ; pl. xvii, fig. 4 ; pl. xviii, fig. 3 ; 1918, Stolley, p. 129, pl. xix, figs. 8, 9 ; pl. xx, figs. 1, 2, 6 ; 1928, Schrammen, p. 38 (*Opheoceratites*) ; 1928, Schmidt, p. 301, text-figs. 829-831.

DIAGNOSIS. Like *C. robustus*, but with the outer whorl more rounded to sub-quadrate in section, and with bi-nodose ornamentation replaced by simple, occasionally projected ribs.

MEASUREMENTS :

Lectotype (Philippi, pl. xxxviii,				
fig. 1)	. . . . .	76	38	32 33
var. <i>crassior</i> , Riedel (pl. x, fig. 1)	. . . . .	78	42	37 26
var. <i>subnuda</i> , Stolley (pl. xix, fig. 8)	. . . . .	79	39	26 32

REMARKS. This relatively small species is rather variable, and there are many transitions between the var. *crassior*, Riedel (with a more inflated whorl-section and stronger costæ), and the var. *subnuda*, Stolley (in which the ribbing is feeble and sometimes almost lost) ; there are also passage forms to *C. robustus* and allied forms like *C. muensteri*. The Collection includes casts of the lectotype of the species (Philippi's [1901] pl. xxxviii, fig. 1, C. 31456 from the original in the Berlin Museum), and of the two transitional forms figured by Philippi

as *C. muensteri* (pl. xxxix, figs. 3 and 6, C. 31457-8), which may also be referred to the present species. There are also casts of two examples of Riedel's var. *crassior* (originals of his pl. x, fig. 1 [C. 31459], and pl. ix, fig. 4 [C. 31460]), and of the var. *subnuda* (Stolley's pl. xix, fig. 8 [C. 31461]).

In addition to a block containing 18 more or less doubtful specimens (which, of course, are not all referable to the present species), there are a few doubtful specimens, listed at the end, which, by their larger size, seem to be transitional to *C. evolutus*; but they are as compressed as the typical *C. compressus*.

HORIZON AND LOCALITIES. Upper Muschelkalk, lower part of Middle Ceratite Beds. Germany.

SPECIMENS :

- 36247.** Brunswick. *Old Coll.*
- C. 339.** Hildesheim. *Presented, Mrs. Burnett, 1882.*
- C. 14762, 14785-6.** Diemarden, nr. Göttingen.
Exchange, E. Mascke, 1906.
- C. 28762.** Königsdahlum, nr. Bokenem.
Dr. A. Schrammen Coll., 1926.
- C. 28737.** Wesseln, nr. Hildesheim. *Same Coll.*
- C. 2795.** Block containing 18 specimens. No locality.
Baber Coll., 1889.
- C. 14768** (var. *subnuda*). Hainberg, nr. Göttingen.
Exchange, E. Mascke, 1906.
- C. 14752.** Diemarden, nr. Göttingen.
Exchange, E. Mascke, 1906.
- C. 28761.** Steuerwald, nr. Hildesheim.
Dr. A. Schrammen Coll., 1926.
- C. 31159.** No locality. *Old Coll.*
(The last three agreeing with Philippi's pl. xxxix, fig. 3).
- C. 14749.** Diemarden, nr. Göttingen.
Exchange, E. Mascke, 1906.
(Agrees with Philippi's pl. xxxix, fig. 6.)
- ? **C. 4865.** Erkerode, nr. Brunswick. *Old Coll.*
- ? **C. 14750, 14754.** Diemarden, nr. Göttingen.
Exchange, E. Mascke, 1906.
- ? **C. 14766.** Hainberg, nr. Göttingen.
Exchange, E. Mascke, 1906.
- ? **C. 28739-41.** Wesseln, nr. Hildesheim.
Dr. A. Schrammen Coll., 1926.

Ceratites evolutus, Philippi.

1915a, Diener, p. 82; 1918, Riedel, p. 40; 1918, Stolley, p. 130, pl. xx, figs. 4, 7; 1928, Schrammen, p. 38 (*Opheoceratites*); 1928, Schmidt, p. 302, text-fig. 833.

DIAGNOSIS. Like *C. compressus*, but larger and (typically) with a more quadrate whorl-section.

MEASUREMENTS :

Type (Philippi, pl. xlii, fig. 1)	.	122	·35	·36	·39
var. <i>tenuis</i> , Riedel	.	90	·36	·27	[2·36]
var. <i>subspinosa</i> , Stolley (pl. xx, fig. 4)	.	100	·44	·37	·31

REMARKS. The typical forms are very rare, and there is only a single example (C. 31166) that agrees with the cast (C. 31462) of Philippi's type. There are several examples, however, of the var. *subspinosa*. The Collection also includes a cast of Stolley's original (C. 31464) as of the example figured in Philippi's pl. xlii, fig. 2 (C. 31681). The var. *tenuis* is represented by a number of specimens, some of them doubtful or worn, and, as Stolley pointed out, it is often difficult to separate *C. evolutus* not only from its immediate precursor, *C. compressus*, but also from forms like *C. raricostatus* and *C. lævigatus*, not to mention the spinose forms of the next higher horizons that are connected with the var. *subspinosa*.

There is also a cast (C. 31463) of an example of the var. *tenuis* in the Naturaliensammlung of Stuttgart, and a cast (C. 31683) of a Bayreuth specimen of the closely allied *C. similis*, Riedel (1916, p. 43, pl. x, fig. 3).

One of the specimens listed below (C. 512) is a malformation, and resembles those pathological examples (of various species of *Ceratites*) that have been described as *C. fastigatus*, Credner (1875, p. 166, pl. v, fig. 7), and *C. brunsvicensis*, Blanckenhorn (1887, p. 32). The Collection includes casts of the types of the last (C. 20260, Bülow, 1917, p. 133, text-fig. 1), and of Philippi's (1901, pl. xl) originals to his figs. 1 (C. 31690) and 3 (C. 31692), also of two more examples of "*C. fastigatus*" from Sattelweiler (C. 31691) and Lichtenau (C. 31693) sent by Dr. Berckhemer, 1928.

HORIZON AND LOCALITIES. Upper Meso-trias, Upper Muschelkalk, Middle Ceratite Beds. Germany; France.

SPECIMENS :

- C. 31166.** Würzburg, Bavaria.
Geol. Soc. (ex D. Sharpe) Coll., presented, 1911.
- C. 21732** (?). No locality (a worn example). *Old Coll.*
- 37174.** Lunéville, Meurthe et Moselle, France.
Tesson Coll., 1857.
- C. 14767.** Hainberg, nr. Göttingen.
Exchange, E. Mascke, 1906.
- C. 14774.** Hochberg, nr. Würzburg.
Exchange, E. Mascke, 1906.
- C. 14779.** Salzburg, nr. Nordheim, Göttingen.
Exchange, E. Mascke, 1906.
- C. 14781.** Versbach, nr. Würzburg.
Exchange, E. Mascke, 1906.
- These five are referable to the var. *subspinosa*, Stolley.
- C. 14773.** Railway Cutting, Hardegsen, Hanover.
Exchange, E. Mascke, 1906.
- C. 28729.** Neuhoof, nr. Hildesheim.
Dr. A. Schrammen. Coll., 1926.
- C. 512.** Weimar (malformation).
Presented C. Westendorp, 1884.
- C. 31151.** No locality. *Old Coll.*
- C. 31165.** Saargemünd, Lorraine. *Old Coll.*
- These four are referred to the var. *tenuis*.
- C. 31162** (?). Crailsheim, Wurtemberg (worn). *Old Coll.*
- C. 31713** (?). Toulon, Var. *Michalet Coll., purchased, 1896.*

Ceratites armatus, Philippi.

1915a, Diener, p. 78; 1918, Riedel, p. 52, pl. xii, fig. 2; 1918, Stolley, p. 133; 1928, Schrammen, p. 38 (*Hoploceratites*); 1928, Schmidt, p. 303 (*non text-fig. 836 ?*).

DIAGNOSIS. Subplatygyral, subleptogyral, subangustumbilicate *Ceratites*. Whorl-section compressed rectangular, but in later stages more divergent, with prominent, sharp spines at the ventro-lateral edges. Inner tubercles small, elongated, and connected with the outer spines by indistinct, falcoid ribs. Suture-line ceratitic.

MEASUREMENTS :

Philippi (1901, pl. xxxvi, fig. 3)	. 73	.47	.34	.18
Riedel (pl. xii, fig. 2)	. 59	.40	[?]	.30

REMARKS. This oldest form of the spinose *Ceratites* is

apparently a development of the *robustus* stock, running more-or-less parallel with the *nodosus* group. As Stolley suggests, it probably differed from the later spinose forms chiefly in its smaller size. The Collection includes a cast (C. 31465) of Philippi's original; but since this species has been described as rare, it is doubtful whether all the forms listed below are referable to *C. armatus*, two of the larger examples in the Schrammen Collection being apparently transitional to *C. spinosus*.

C. præcursor, Riedel (1918, p. 53, pl. xii, figs. 3 [lectotype] and 4); and *C. præspinus*, Riedel (1918, p. 54, pl. xii, figs. 5a, b [lectotype], 6, pl. xiii, fig. 1), are represented in the Collection only by casts (C. 31688-9). They have been considered to be younger mutations of *C. armatus*, but Riedel's figure of *C. præcursor* (pl. xii, fig. 4) is so much like Philippi's type of *C. armatus* that Schmidt figured it as this species (text-fig. 836), whilst his *C. præcursor* (text-fig. 837) is Riedel's *C. armatus* (pl. xii, fig. 2).

HORIZON AND LOCALITIES. Upper Meso-trias, Middle Ceratite Beds, *spinus* (= lower *nodosus*) Beds. Germany.

SPECIMENS :

C. 28714-16. Harz, nr. Bokenem, Hanover.

Dr. A. Schrammen Coll., 1926.

C. 31124. No locality.

Old Coll.

Ceratites spinosus, Philippi.

1915a, Diener, p. 89; 1918, Riedel, p. 55, pl. xiii, figs. 2, 4; pl. xiv, figs. 1-3; pl. xviii, fig. 2; 1928, Schrammen, p. 39 (*Acanthoceratites*); 1928, Schmidt, p. 304, fig. 839.

DIAGNOSIS. Like *C. armatus*, but more evolute and larger.

MEASUREMENTS :

Holotype (Philippi, 1901,

pl. xli, fig. 1)	130	·44	·41 (?)	·26
Riedel, pl. xiii, fig. 2	75	·37	·45	·32

REMARKS. Riedel stated that Philippi's holotype was not very "characteristic", and he included in the synonymy of this species Philippi's *C. evolutus* (pl. xlii, fig. 2), which differs from the type of the latter species in having outer spines. The Collection includes a cast of this form, but this and comparable examples have already been referred to (p. 485) as a var. *subspinosa* of *C. evolutus*. We may consider *C. spinosus*

to be a development of *C. robustus*, as Riedel suggests, not by way of the earlier and smaller *C. armatus* or *C. præcursor*, but by *C. evolutus* and *C. compressus*.

C. postspinosus, Riedel (1918, p. 58, pl. xiv, fig. 4, pl. xv, fig. 1 [lectotype], 2, pl. xvi, fig. 1), which differs from the species here described in its smoother inner whorls, more rapid growth and greater involution, is represented in the Collection only by a cast (C. 31680) and, perhaps, one of the examples (C. 14776) listed below.

HORIZON AND LOCALITIES. Upper Meso-trias, Middle Ceratite Beds, *spinosus* (= lower *nodosus*) Beds. Germany.

SPECIMENS :

C. 31163. Hall, Germany. Old Coll.

C. 14776. Elliehausen, Göttingen. *Exchange, E. Mascke*, 1906.

C. 28711-12, 28717. Harz, nr. Bokenem, Hanover.

Dr. A. Schrammen Coll., 1926.

C. 28754-5. Bültem, nr. Bokenem, Hanover.

Dr. A. Schrammen Coll., 1926.

C. 31150, 31155, 31161 (?). No localities.

Old Coll.

***Ceratites toulonensis*, Riedel.**

1918, p. 68, pl. xvii, fig. 2.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Ceratites*. Whorl-section polygonal, ornamentation at first bi-nodose, with lateral tubercles above the middle of the sides. The outer tubercles disappear towards the body-chamber, and the ventral edge is only faintly marked, whilst the lateral spines move outwards so as to resemble the prominent ventral tubercles in the spinose *Ceratites*. Single ribs across the whorl-side, passing from what are first inner, then apparently outer tubercles, to the umbilical suture. Suture-line as in other *Ceratites*.

MEASUREMENTS :

Riedel, pl. xvii, fig. 2	85	·35	·35 (?)	·33
C. 12529	82	·37	·34 (?)	·34

REMARKS. This form was (apparently correctly) placed by Riedel with *C. tornquisti*, Philippi (1901, p. 389, pl. xxxix, figs. 2, 2a), and *C. thuringiacus*, Riedel (1918, p. 66, pl. xvii, fig. 3), which are very closely allied. He considered these to belong to a special group of Mediterranean forms, but the differences from typical *Ceratites* of the type of *C. muensteri* (in the wider sense) are slight.

HORIZON AND LOCALITIES. Upper Meso-trias, Upper Muschelkalk. Middle Ceratite Beds. Var (France); Germany; Alps (?).

SPECIMENS :

- C. 12529. Lagoubran, nr. Toulon. *A. Michalet Coll.*, 1910.
C. 31711-12. Toulon. *Same Coll.*, 1896.

Genus **DISCOCERATITES**, Schrammen.

1928, p. 42.

GENOTYPE. *Ceratites intermedius*, Philippi, emend Benecke (1911, p. 594; 1914, p. 95 = Philippi's [1901] pl. xlix only).

DIAGNOSIS. More-or-less smooth and involute, large, discoidal Ceratitidæ, resembling *Ceratites*, with narrow, to almost oxynote, venters.

RANGE. Uppermost zones of the Germanic Upper Muschelkalk, immediately below the "Lettenkohle" (= Lower Keuper).

REMARKS. The forms here grouped in *Discoceratites* are closely connected with the *nodosus* assemblage of true *Ceratites* by such transitional forms as *C. levalloisi*, Benecke, based on one of Philippi's *C. "intermedius"* (pl. l only). The Collection includes a cast (C. 31684) of the holotype of *C. levalloisi*, but no other specimens that could be attached to this form beyond doubt. In the case of a number of ornamented young, however, here referred to *D. dorsoplanus*, as in the case of the inner whorls of Philippi's figs. 1-3 (pl. li), specific identification would be impossible.

Discoceratites intermedius (Philippi).

Fig. 159.

1901, p. 418, pl. xlix, fig. 1; Benecke, 1911, p. 594; 1914, p. 95; Diener, 1915a, p. 83; Riedel, 1918, p. 59; Schrammen, 1928, p. 42; Schmidt, 1928, p. 306, text-fig. 842.

DIAGNOSIS. Subplatygyral, subpachygyral, subangustumbilicate *Discoceratites*. Whorl-section at first greatly compressed, with flat sides and truncate venter; in later stages inflated, with very broad venter; and finally again elliptical. Inner whorls almost smooth, with fine, sharp tubercles at the ventral edges, coarse pleats on the body-chamber, with prominent outer nodes, but becoming smooth again near the aperture. Suture-line as in *C. dorsoplanus* (fig. 159).

MEASUREMENTS :

Philippi, pl. xlix	.	.	160	.	.44	.	.37	.	.21
„ text (inner whorls)	—	.	.45	.	.19	.	—	.	—

REMARKS. The first set of measurements was taken from a cast (No. 31682) of Philippi's original, but the inner whorls are

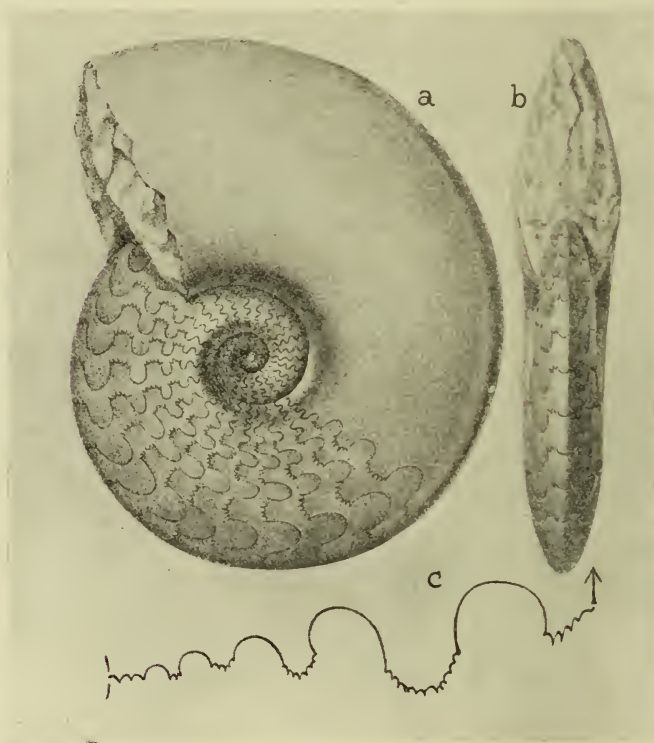


FIG. 159.—*Discoceratites semipartitus* (Montfort), v. Buch sp. a, b, Side- and peripheral views of a Lunéville example (greatly reduced) from the Upper Muschelkalk. (After Pictet, 1853, pl. lii, fig. 8.) c, Suture-line of a Rechainviller specimen. (After Philippi, 1901, pl. liv, fig. 1b.)

far more compressed, and when isolated, could not be distinguished from a number of the examples listed below under *D. dorsoplanus*. There are two very large, put poorly preserved, examples (C. 28704, 28710) that show blunt ribs at a size considerably larger than the holotype of the present species.

These also probably belong to *D. intermedius*; but there are yet other forms that are transitional in various ways to *D. dorsoplanus*.

HORIZON AND LOCALITIES. Upper Meso-trias, Upper Muschelkalk, Upper Ceratite Beds. Germany; France.

SPECIMENS :

C. 31152, 31160. Locality unknown. *Old Coll.*

C. 28704. Steige, nr. Ungsterode, Meissner.

Dr. A. Schrammen Coll., 1926.

C. 28710. Trubenhausen, Meissner.

Same Coll.

Discoceratites dorsoplanus (Philippi).

1901, p. 419, pl. lii only (lectotype); Benecke, 1914, p. 95; Diener, 1915a, p. 81; Riedel, 1918, p. 61; Schrammen, 1928, p. 42; Schmidt, 1928, p. 306, text-fig. 843 on p. 307.

DIAGNOSIS. Platygyral, subleptogyral, angustumbilicate *Discoceratites*. Whorl-section compressed elliptical, with narrow, smooth and flat venter, bordered by two sharp edges. Occasionally with small tubercles at the ventro-lateral edges in the young, or even with bi-nodose ribbing, but the body-chamber is always smooth, except in the var. β (Benecke), which has distinct pleats, and is transitional to *D. intermedius*. Suture-line as in last.

MEASUREMENTS :

Lectotype (Philippi, pl. lii)	165	.	.52	.	.28	.	.15
Text (pp. 76-7)	250	.	.52	.	.35	.	?

REMARKS. If the example figured by Philippi in pl. 1, fig. 2 (of which there is a cast in the Collection, C. 31697), really corresponds with the inner whorls of the larger lectotype (pl. lii), the ornamented specimen represented in Philippi's pl. li, fig. 3, is undoubtedly specifically distinct. Casts of both these forms are also in the Collection (C. 31695-6). The difficulty of satisfactorily identifying the discoidal type of ceratites has already been discussed by Benecke, but until more favourably preserved material is available, it seems advisable to consider the less typical examples listed below as transitions to *D. intermedius* and *D. levallouisi* (Benecke). Only the first twelve specimens listed are the typical, flat and smooth *D. dorsoplanus*, but of these as many as five (in the Schrammen Collection) had been attributed to *D. semipartitus*, instead of the present species.

HORIZON AND LOCALITIES. Upper Meso-trias, Upper Muschelkalk, Upper Ceratite Beds (*dorsoplanus* zone). Germany ; France.

SPECIMENS :

50176. Brunswick. *Prof. J. Morris Coll.*, 1867.
 C. 21733. Locality unrecorded. *Old Coll.*
 C. 1716. Illingen, nr. Simsheim. *J. E. Lee Coll.*, 1885.
 C. 14778. Penk, nr. Bayreuth. *Exchange, E. Mascke*, 1906.
 C. 28721-22, 28691, 28695-6, 28698. Sultemerberg, nr. Northheim, Hanover. *Dr. A. Schrammen Coll.*, 1926.
 C. 28736, 28707, ? 28705. Steige, nr. Ungsterode. *Same Coll.*
 (?) C. 28699, 28700-01, 28713. Sultemerberg, nr. Northheim, Hanover. *Same Coll.*
 C. 14783. "Hellaleide", nr. Landenbach, Meissner. *Exchange, E. Mascke*, 1906.
 C. 14782. Langfeld, nr. Würzburg. *Same Coll.*
 (?) C. 5855. Toulon (Var.), France. *R. F. Damon*, 1896.

Discoceratites semipartitus (Montfort), v. Buch sp.

1849, p. 9, pl. iii, figs. 1, 2 (lectotype) ; Diener, 1915*a*, p. 88 ; Riedel, 1918, p. 63 ; Schrammen, 1928, p. 42 ; Schmidt, 1928, p. 307.

DIAGNOSIS. Like *D. dorsoplanus*, but with compressed, almost acute, venter and therefore more lanceolate whorl-section.

MEASUREMENTS :

Von Buch, pl. iii, figs. 1, 2 .	300	·44	·25	·17
Riedel, p. 64	365	·51-·54	·24-·39	(?)
C. 7165	270	·44	·19 (?)	·17

REMARKS. Von Buch's original figure seems badly drawn, but there is close correspondence in the measurements with the characteristic toptype above quoted (C. 7165). The whorl-height, however, is considerably greater in the example figured by Philippi (1901, pl. liv), as it is in an entirely septate Hagenbach example of 200 mm. diameter in the Naturalien-sammlung, Stuttgart, of which there is a cast in the Collection (C. 31698). Another large example (46585) is still camerated at 260 mm. diameter, but some of the smaller examples listed below have a truncate venter slightly wider than the typical large specimens, and like the originals of Philippi's pl. liii and von Buch's pl. ii, figs. 2 and 3, may be considered to be passage forms to *D. dorsoplanus*.

HORIZON AND LOCALITIES. Upper Meso-trias, Upper Muschelkalk, Upper Ceratite Beds, *semipartitus* zone. France; Germany.

SPECIMENS :

37034. Lunéville, France. *Tesson Coll.*, 1857.
 C. 7165. Same locality. *Castelli Coll.*, 1898.
 46585. Fürfeld, nr. Heilbronn, Wurtemberg. *Dr. Bruckmann Coll.*, 1858.
 46586. Crailsheim, Wurtemberg. *Dr. Bruckmann Coll.*, 1858.
 C. 28690, 28692-4, 28697. Sultemerberg, near Northeim, Hanover. *Dr. A. Schrammen Coll.*, 1926.

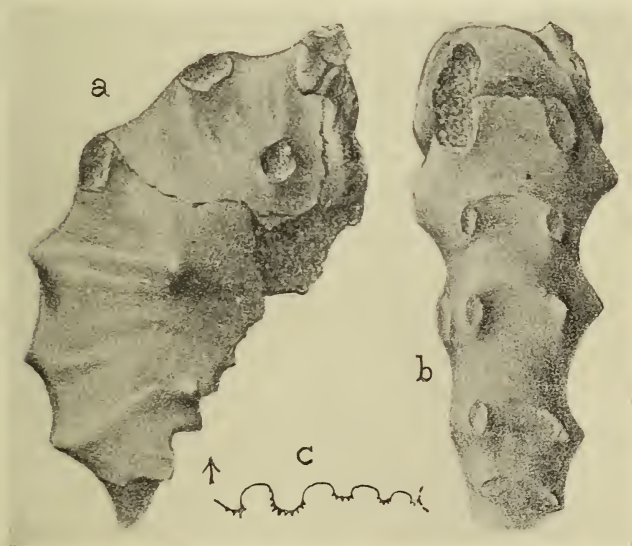


FIG. 160.—*Alloceratites schmidi*, Zimmermann. Upper Trias. Lettenkohle (Grenzdolomit), Thuringia. (After Philippi, 1901, pl. xxxvi, figs. 5, 5a, 5d.)

Genus **ALLOCERATITES**, nov.

GENOTYPE. *Ceratites schmidi*, Zimmermann, 1883, p. 382, text-figs. 1-3, p. 383.

DIAGNOSIS. Ceratitidæ which are flat, discoidal and smooth in young, with truncate venter, as in *Discoceratites*; but later have prominent lateral tubercles and peripheral clavi, bordering a subsulcate periphery. With indistinct ribbing between the

tubercles on the whorl-side, and ribs with a strong forward sinus connecting the peripheral clavi. Suture-line ceratitic, with wide and shallow lobes and two distinct auxiliary saddles and lobes, instead of the serration found in *Discoceratites*.

DISTRIBUTION. Lowest Neo-trias, Keuper (Upper Lettenkohle = "Grenzdolomit"). Germany.

REMARKS. Its author considered this form to be allied to the late ceratites of the *nodosus* and *semipartitus* groups, but Philippi, who, in 1901 (p. 425, pl. xxxvi, figs. 5, 5a-d), gave a better figure of the holotype, as well as a figure of a cast of its inner whorls, took it to be an extremely (but secondarily) primitive type. On examining the dorsal, *i. e.* sectional, aspect of the unique holotype (of which there is a cast [C. 31694] in the Collection), one is struck with the resemblance to certain Lower Cretaceous *Engonoceras* and Senonian *Placenticeras*. In these genera also, compressed, truncate and more-or-less smooth inner whorls may suddenly change to an inflated, highly ornamented outer whorl. *Alloceratites* thus may well represent a specialized offshoot of *Discoceratites*, the similarity to the immature *D. dorsoplanus* (see Philippi, 1901, pls. l and li) being particularly close.

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EXPLANATION OF PLATES



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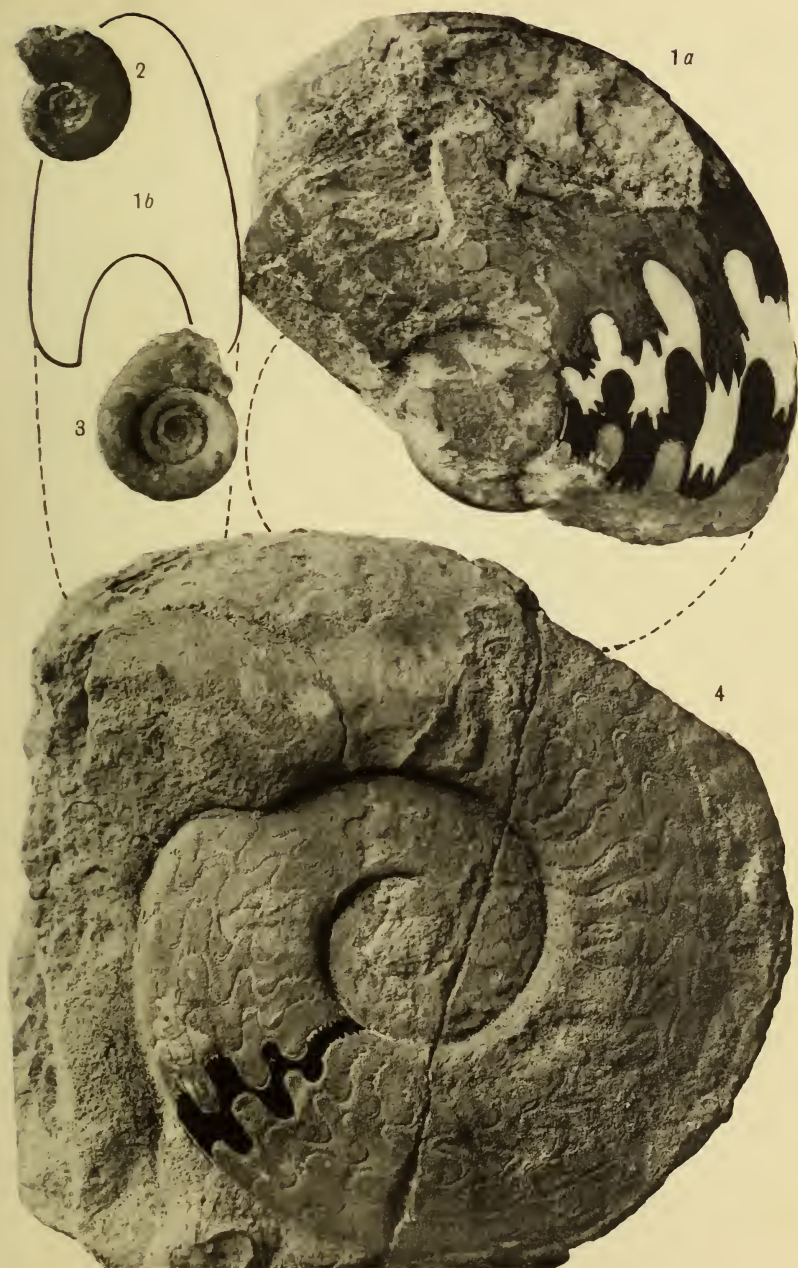
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GLYPTOPHICERAS, LYTOPHICERAS, ACANTHOPHICERAS.



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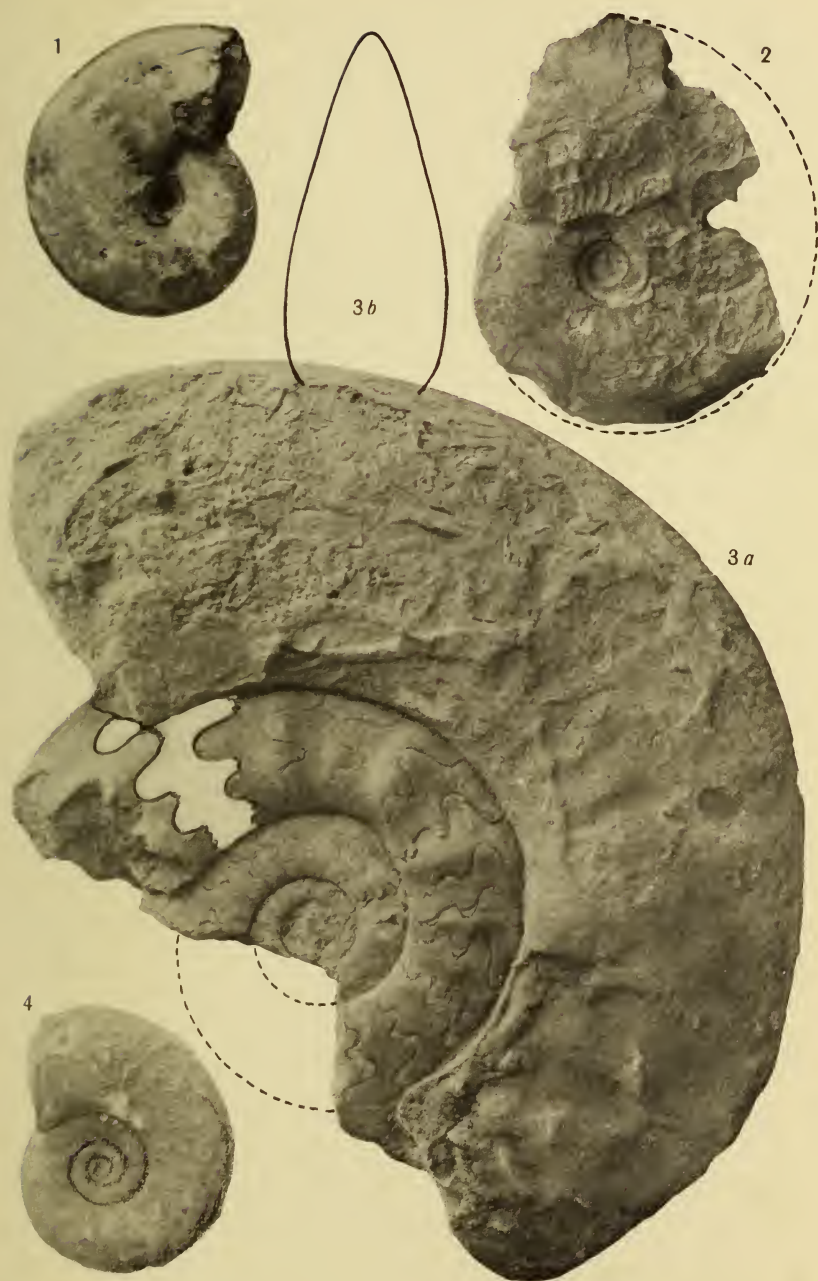
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PROPTYCHITES, XENOCALTITES, EOPHYLLITES,
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PROCARNITES, PARASPIDITES, XENODISCOIDES?,
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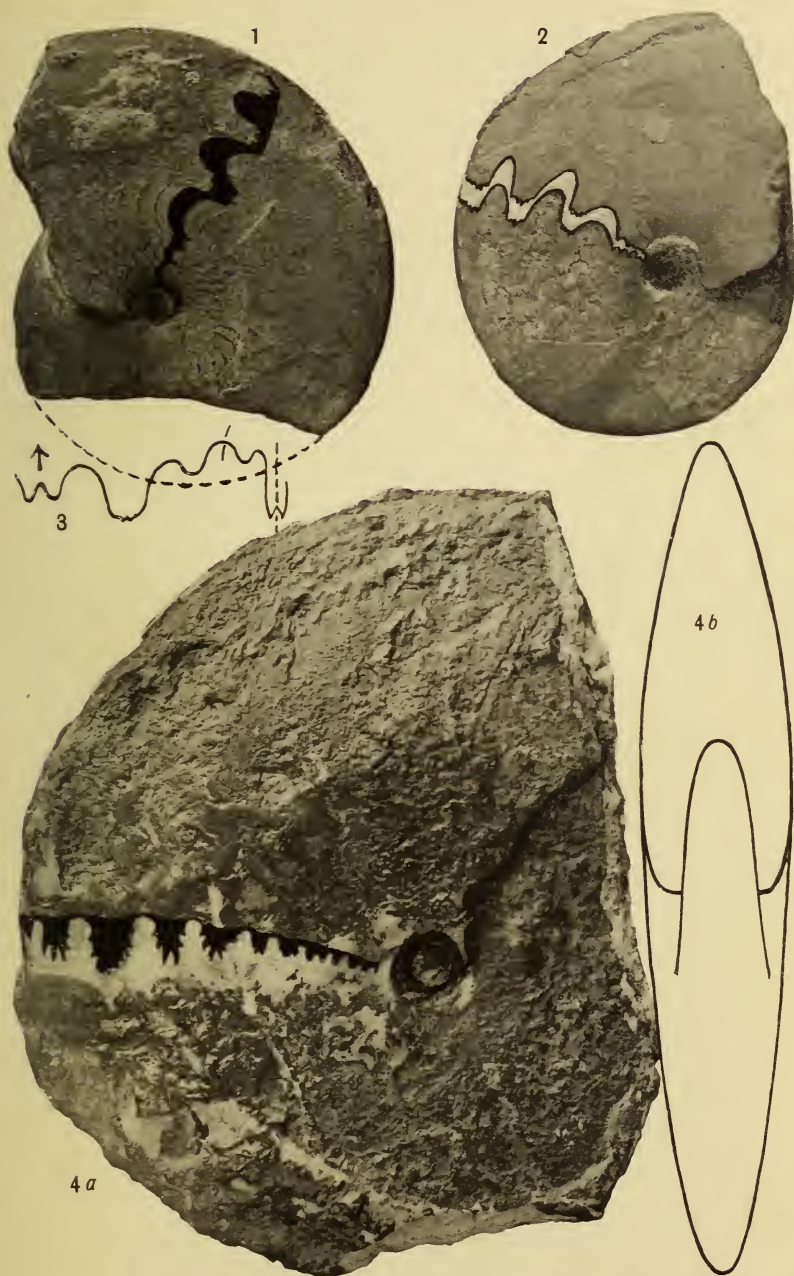
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PARANORITES, PROPTYCHITOIDES, DIPHYLLITES,
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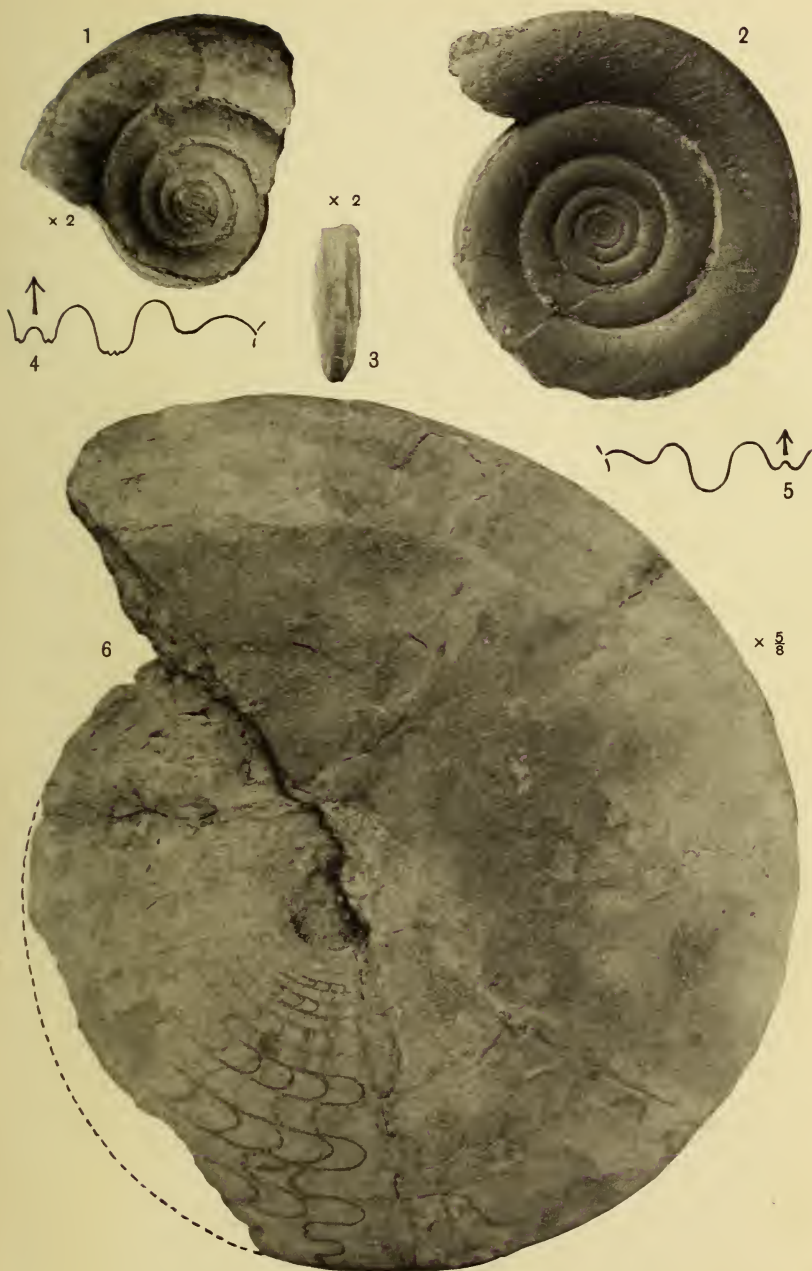
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KONINCKITES, XENOCELITTES, PROCARNITES.



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EOPHYLLITES. LEIOPHYLLITES, TELLERITES,
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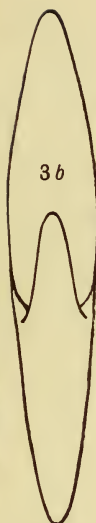
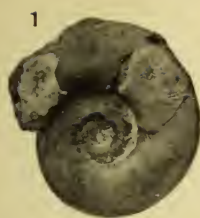
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EOPHYLLITES, DAGNOCERAS, OLENIKITES,
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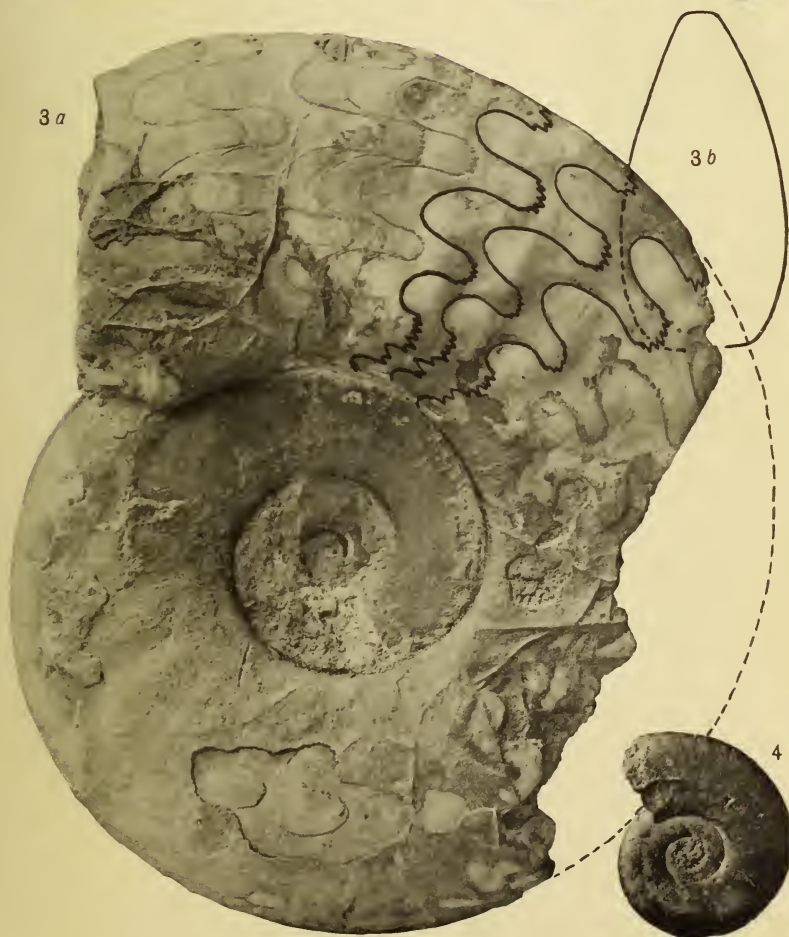
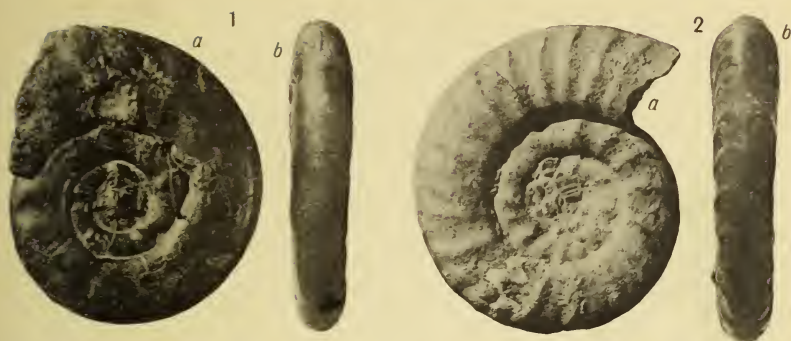
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DAGNOCERAS, XENOCALTITES, CLYPEOCERAS,
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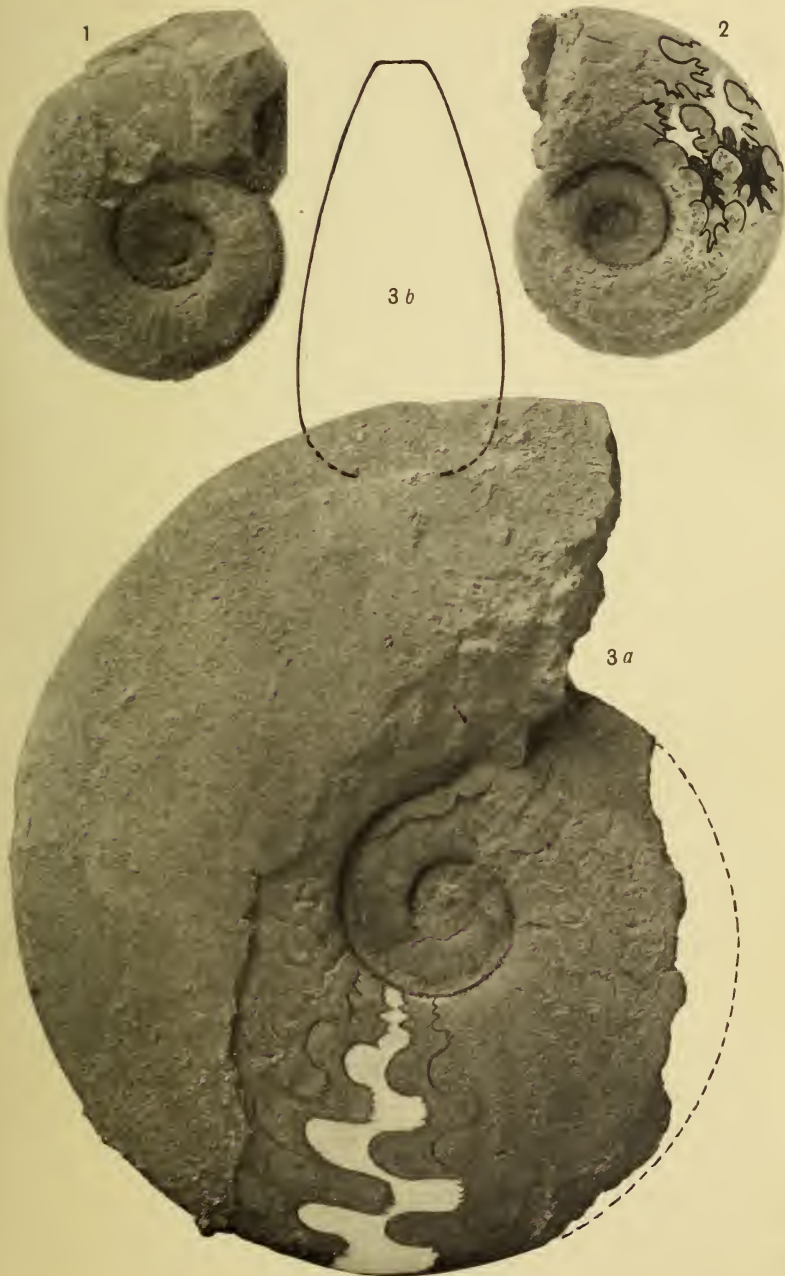
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XENOCELTITES, PARANORITES.



PLATE X.

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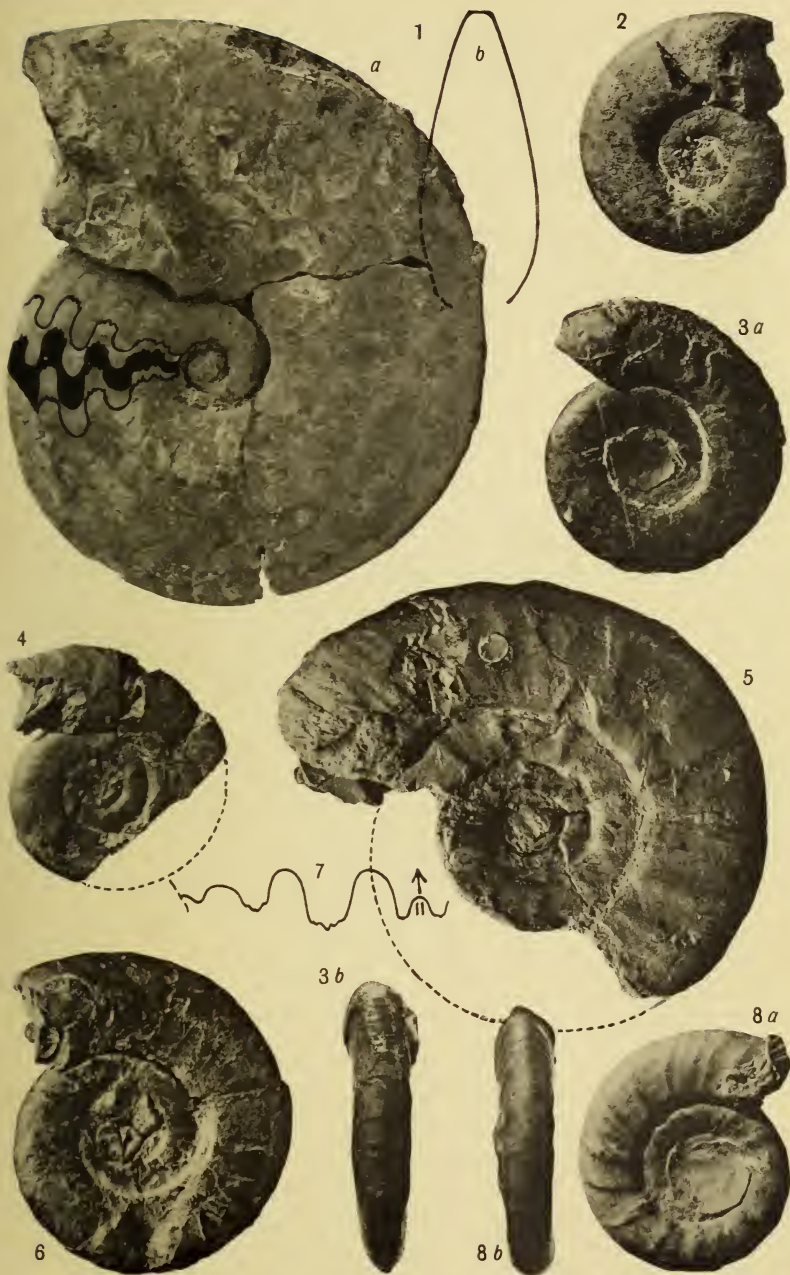
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MONOPHYLLITES, USSURITES?, PARANORITES,

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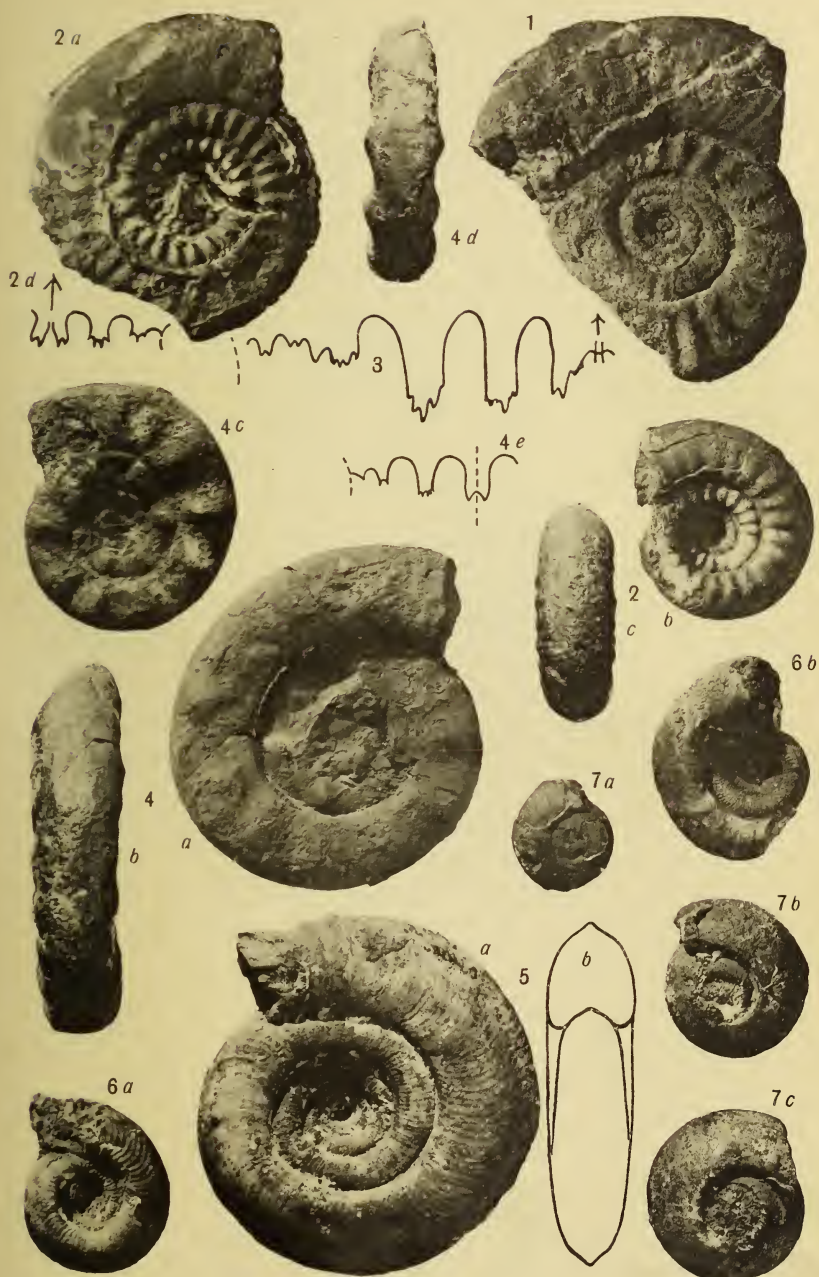
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KONINCKITES, XENOCALTITES.



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GLYPTOPHICERAS, PREFLORIANITES, CLYPEOCERAS,
ANAKASHMIRITES, SUBCOLUMBITES, PRENKITES.



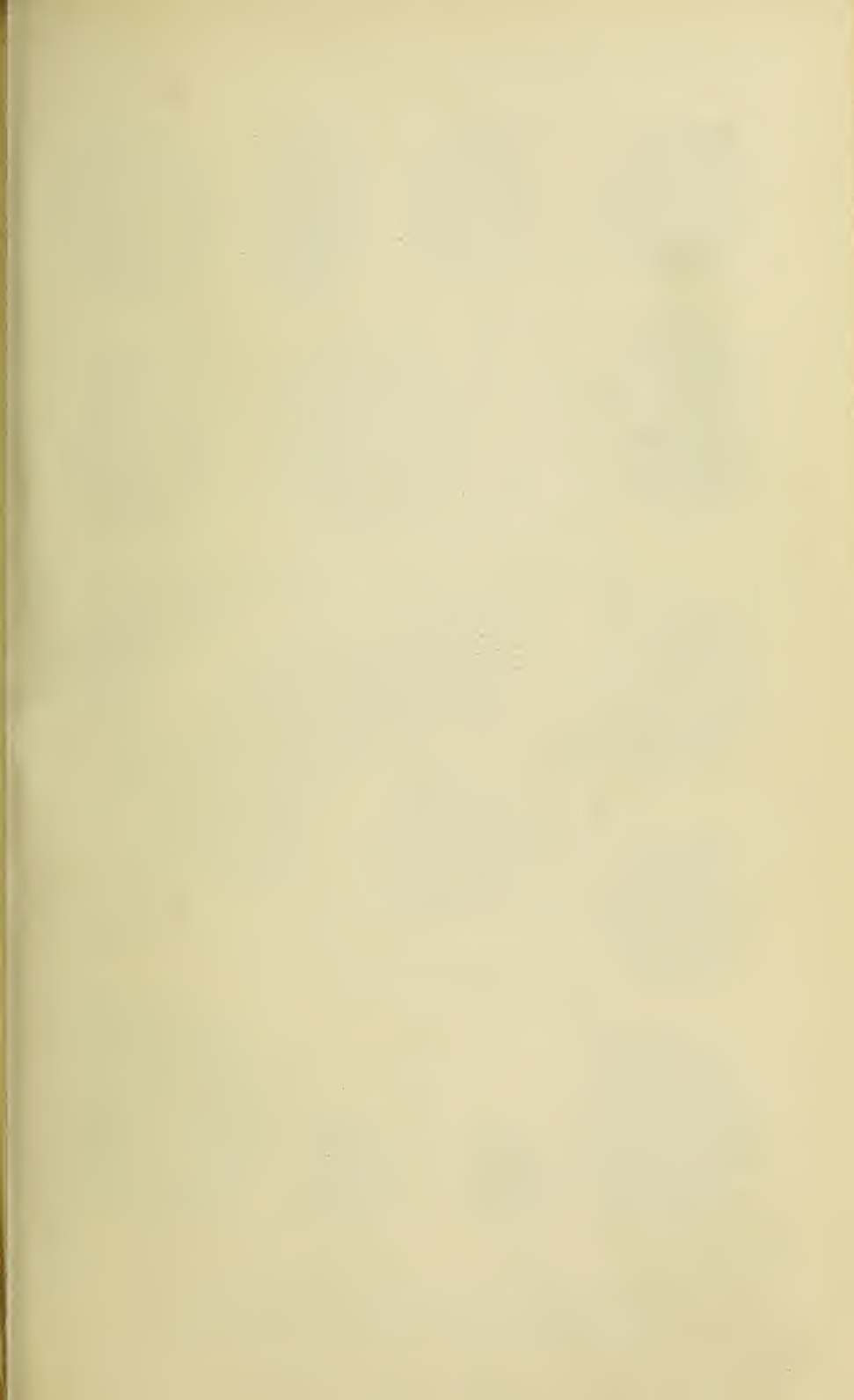


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* ["*Juvenites*" on the plate.]



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PROSPHINGITES, COLUMBITES, PROTROPITES,
EPICELTITES, JUVENITES, HEMILECANITES.



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* ["*Juvenites*" on the plate.]



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**JUVENITES, ISCULITOIDES, ARCTOPRIONITES,
PARANANNITES.**



PLATE XV.

FIG.		PAGE.
1a-c.	<i>Gurleyites</i> ("Arctoprionites")* <i>freboldi</i> , sp. nov. Holotype, with suture-line and outline whorl-section. Upper Eo-trias. Spitsbergen. (C. 27157.)	339
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[* Names used on the plate.]



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ARCTOPRIONITES, KEYSERLINGITES.



PLATE XVI.

FIG.	PAGE.
1, 3. <i>Hemiprionites garwoodi</i> , sp. nov. Holotype and paratype. (Peripheral views on Pl. XVII, figs. 3, 5.) Upper Eo-trias. Spitsbergen. (C. 27156 and 27154.)	336
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[* Names used on the plate.]



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ARCTOPRIONITES, KEYSERLINGITES.





PLATE XVII.

FIG.	PAGE.
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3, 5. <i>Hemiprionites garwoodi</i> , sp. nov. Peripheral views of holotype (5) and paratype (3) figured in Pl. XVI, figs. 1 and 3. Upper Eo-trias. Spitsbergen. (C. 27156 and 27154.)	336
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ARCTOPRIONITES, BEYRICHITES?, MONOPHYLLITES,
PARACERATITES.



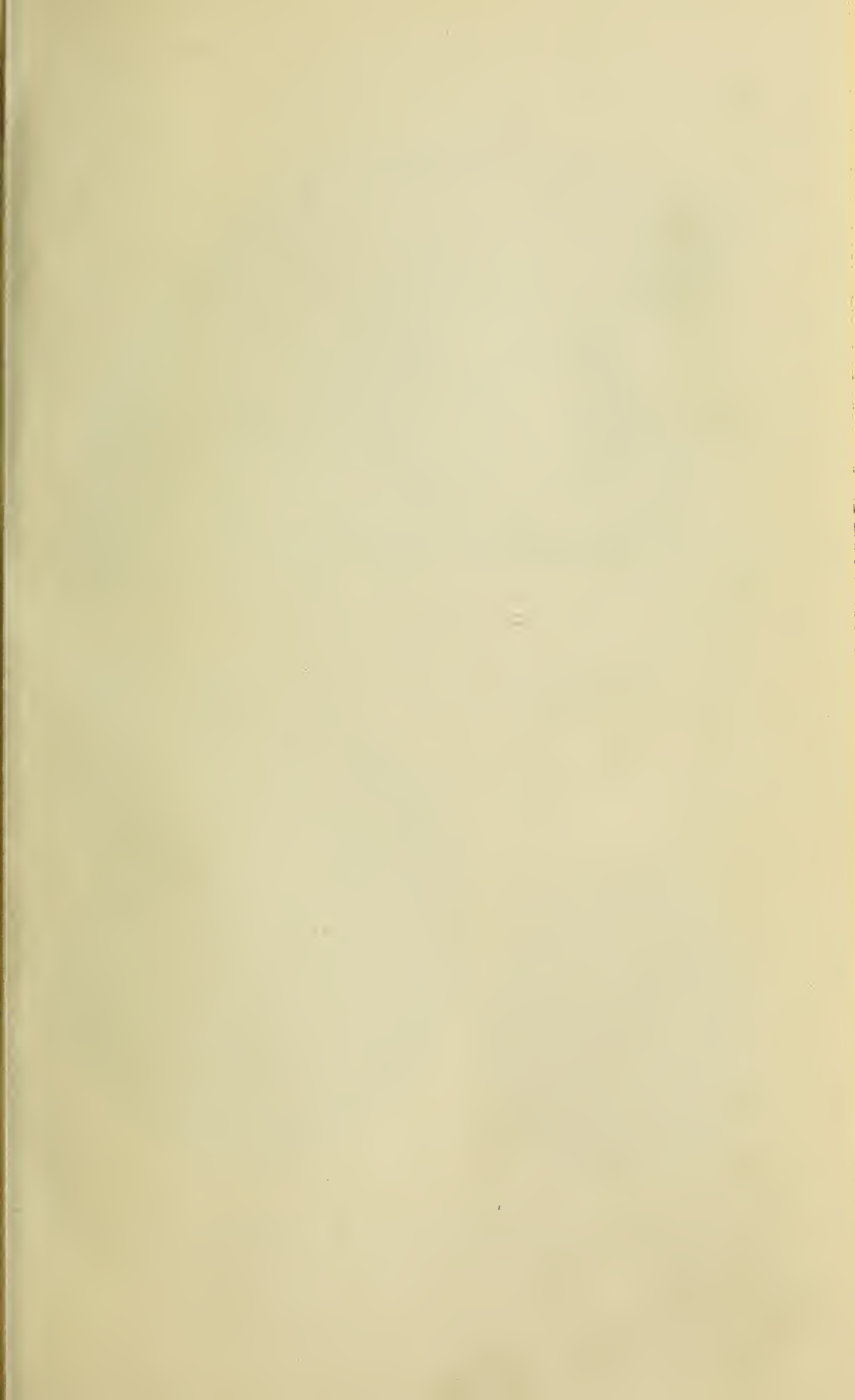




PLATE XVIII.

FIG.		PAGE.
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ARCTOPRIONITES, EPACROCHORDICERAS, NICOMEDITES.



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